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The Impact of Lost Time and Disability Management on Healthcare Service Utilization and Expenditure Among Texas Workers' Compensation Commission Claimants

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The Impact of Lost Time and Disability Management on Healthcare Service Utilization and Expenditure Among Texas Workers' Compensation Commission Claimants

by

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The Impact of Lost Time and Disability Management on Healthcare Service Utilization and Expenditure Among Texas Workers' Compensation Commission Claimants

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The purpose of this study was to identify and examine relationships between disability management practices, lost time, and system expenditures related to workers' compensation injury and disability. The study was conducted using primary event data provided by the Texas Workers' Compensation Commission and short- and long-term data of successfully implemented disability management programs from other settings. Bivariate analyses determined if statistical and practical relationships existed between independent variables and variables reporting expenditure, medical service utilization (MSU), and time off work data. Regression models were developed to estimate likely

expenditure, MSU, and time off work based on claimant characteristics. Finally, a costing model was developed to estimate long-term savings associated with implementing disease management programs in Texas.

Results of the bivariate analyses showed statistically significant associations at $p < 0.001$ for most relationships between the independent variable and expenditure, MSU, and time off from work. Findings included significant differences in medical expenditure by practitioner type, MSU variation by the region of state in which care was provided, and differences in medical expenditure by gender. Regression analyses results indicated that there was little predictive value for any of the eight outcome variables assessed despite attaining statistical significance at $p < 0.001$. These models explained only 3.1% to 13.2% of the variance in each model.

Results of the cost estimation model indicated that substantial savings may be obtained for treating injuries of at least 30 days and less than two years in length after implementing a disability management model in Texas. Specific savings depend on the type of disability management intervention, injury group targeted, and the intensity to which the interventions are integrated into the workers' compensation care process. All models indicated that an increased penetration rate is associated with greater savings. However, incremental savings in all models gradually decrease over time as costs of the program begin to offset the benefits. Overall, the potential for disability management treatment planning to provide significant cost savings to Texas employers, as compared to continuing with the status quo, is substantial.

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1. Introduction

1.1. Background and Significance

Workplace injuries are a common occurrence in the United States workforce. In 1997, the US National Institute for Occupational Safety and Health estimated that more than 5.7 million non-fatal occupational injuries occurred.[1] The numbers of non-fatal injuries ranged from a low of 2 per 100 full-time workers in the finance, insurance, and real estate sectors to a high of 9 per 100 full-time workers in the construction industry. Fatal workplace accidents also represent a high burden to society.[2] From 1980 to 1995, the US National Traumatic Occupational Fatalities Surveillance (NTOF) system recorded 93,929 job-related civilian deaths.[3] The average annual fatality rate was 5.3 per 100,000 workers nationally during this period.[4]

On the state level, Texas reported 61,320 injuries between January and June 2004.[5] Sixty-two percent of the reported injuries occurred in male workers and 38% occurred in female workers.[6] The number of occupational fatalities reached an all time low in 2002, with 417 fatalities reported.[7] A total of 27.1 percent (N=113) of these occupational fatalities occurred in the construction industry followed by 16.1 percent (N=67) in

[1] NIOSH. Worker Health Chartbook, 2000. US Department of Health and Human Services, Centers for Disease Control and Prevention. Bethesda, MD September, 2000: 89-111.
[2] *Ibid.*
[3] NIOSH. Worker Health Chartbook, 2000. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Bethesda, MD September 2000: 29-49.
[4] *Ibid.*
[5] Texas Workers' Compensation System Data Report. Texas Workers' Compensation Commission. Austin June 2004: 1-58.
[6] *Ibid.*
[7] Texas Workers' Compensation Commission. Occupational Fatalities in Texas at an All-Time Low. September 17, 2003. Available at: http://www.twcc.state.tx.us/news1/newsreleases/news030917.html. Accessed: January 28, 2004.

transportation and public utilities, and 14.2 percent (N=59) in retail and wholesale trade.[8] It should be noted that the Bureau of Labor and Statistics no longer calculates an occupational fatality rate due to methodological and technical problems. Therefore, occupational fatality comparisons to other states using raw numbers should be avoided or discerned with this knowledge. Morbidity figures in Texas as measured by the number of lost-work time days for workers reaching maximal medical improvement after injury increased from an average of 82 days in 1998 to 116 days in 2000.[9]

From 1992 to 2001, the incidence of injury and illness reported per 100 full-time Texas workers decreased from 7.3 to 4.9 events.[10] This corresponds with similar trends seen nationally. Despite decreases in non-fatal and fatal occupational injury incidence, costs associated with medical claims represent a considerable burden to Texas employers. For example, from 1993 to 1998, average workers' compensation medical only insurance costs (with a 6-month valuation) paid by a multi-state insurance company in Texas increased 17.1% from $334 to $403, compared to out-of-state payment increases of 12.5% from $258 to $294. In addition, medical costs are the primary driver of increased WC expenditure, with indemnity payments for wage replacement and disability rising only slightly.

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[8] *Ibid.*
[9] Texas Workers' Compensation Commission. Texas Workers' Compensation System Data Report. Strategic Planning Division. Austin, TX June 30, 2003: 1-38.
[10] *Ibid.*

Considering these trends, the Texas Workers' Compensation Commission (TWCC) faces several challenges which include: (1) ensuring workers receive appropriate and timely treatment; (2) ensuring treatment is provided by the most appropriate medical provider consistent with the specific injury or illness; (3) providing treatment using the most appropriate medical management model based on current evidence; and (4) ensuring that workers' compensation meets the needs of all stakeholders including workers, employers, providers, and the legislature.

1.2. Purpose of Project

The purpose of this project is to identify and examine relationships between lost time, disability management practices, and system expenditures related to workers' compensation injury and disability. Specifically, it seeks to: (1) identify factors contributing to prolonged disability within the Texas Workers' Compensation system; (2) identify time loss and disability management programs in other settings; and (3) develop a disability management model that can estimate the effects of time loss and disability management programs on work loss and health care utilization and expenditures. In doing so, this project aims to assist efforts by TWCC to address rising utilization and expenditures and to improve the efficiency of health service provision by providers.

1.3. Historical Context of Workers' Compensation

Workers' compensation (WC) has its historical roots beginning in the industrial revolution of the mid- to late-18th and early 19th centuries. During this time period, and in the immediately preceding agricultural revolution, factory and business owners did not place a high priority on worker safety. Workers were often exposed to unsafe work practices and horrendous working conditions as well as long hours with low pay. Workers injured at the workplace were often left crippled and did not receive compensation.[11] Indeed, during this time period laws favored industry, thus making it difficult for a worker to prevail in civil court against his employer over a work-related injury.

The German Chancellor Otto von Bismarck first introduced labor protection legislation in the 1850s. It was he "who recognized the societal need of … injured workers and concluded that employers should pay for a system of wage loss compensation for workers injured on the job [since] it was employers who controlled the worksite and reaped the fruit of the workers' labor."[12] The Prussian Federation led by von Bismarck required employers in certain industries to contribute to an accident insurance fund.[13] In all, von Bismarck established three laws to help relieve the plight of workers: (1) the Health Insurance of Workers Law of 1883; (2) the Accident Insurance Law of 1884; and (3) the Old Age and Invalidity Insurance Law of 1889.[14]

Over time, other countries saw merit and enacted similar legislation to provide injured workers with disability and indemnity income. In 1880, the British Parliament passed the

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[11] Carr JD. Workers' compensation systems: purpose and mandate. *Occupational Medicine* 1998;13(2):417-422.
[12] *Ibid*.
[13] *Ibid*.
[14] Williams Jr. CA (1991). An international comparison of workers' compensation. Boston, MA, Kluwer Academic Publishers: 117-197.

Employer's Liability Act that, among other things, provided an injured worker up to three years compensation from his employer. Interestingly, under this act workers were allowed to waive their right of protection, an action that employers encouraged.[15] In 1897 and 1906, England passed revised workers' compensation acts requiring employers to participate in WC insurance. Employers not participating in WC insurance could be subsequently held individually liable if workers sued for injury-based compensatory damages.[16]

Canada and the United States followed England's lead and implemented WC regulations beginning in the early 1900s. Prior to enacting WC legislation in the United States, the only recourse for injured workers seeking damages for work-related injuries was to file suit in civil court. Injured workers were often unsuccessful in obtaining damages because of common law defenses in place at the time. Three defenses comprised the unholy trinity of defenses and included the following provisions:[17,18]

1. Assumption of risk: Individual workers were assumed to have accepted hazards associated with their job and employers were absolved from liability if the worker knowingly agreed to the risk. In addition, workers who continued to work in a

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[15] Carr JD. Workers' compensation systems: purpose and mandate. *Occupational Medicine* 1998;13(2):417-422.
[16] *Ibid*.
[17] *Ibid*.
[18] Diorio PG and Fallon LF, Jr. Occupational medicine. Workers' compensation, impairment and disability. *Occupational Medicine* 1989;4(1):145-151.

specific job were deemed to agree to the risks of that job – even if the job was unsafe.[19]

2. Fellow servant rule: Injuries caused by a co-worker were not compensable by the employer. Instead, workers would have to seek damages from the co-worker directly.

3. Contributory negligence: Workers who contributed to their negligence, even slightly, could not hold the employer liable.

In addition to the above common law defenses, workers faced other common law defenses such as: "acts of God, acts of a third party, inevitable accident, consent, no duty of care, no proximate cause, and self-defense."[20] Eventually WC legislation in the United States adopted the universal immunity rule, which gave employers immunity to civil suits arising from work-related injury or illness if workers' compensation insurance was provided to employees. As such, workers' compensation became "a statutory condition [forming] part of the worker's contract of employment and is a benefit to all workers covered by the legislation in no less a manner than other statutory conditions of work, such as minimum wage."[21] Beginning in 1911, WC legislation containing the universal immunity rule was adopted by most states. Texas does not mandate employer participation in WC; however, a WC program must cover Texas state institutions and certain employers contracting with the Texas state government.

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[19] Carr JD. Workers' compensation systems: purpose and mandate. *Occupational Medicine* 1998;13(2):417-422.
[20] *Ibid.*
[21] *Ibid*.

Major components of United States workers' compensation programs include providing disability benefit payments, medical care, and rehabilitation to workers injured on the job. As noted above, workers gave up their right to seek civil damages in a court of law under the universal immunity provision in exchange for employers agreeing to compensate workers for work-related injuries.[22] Employers meet WC obligations by purchasing insurance through a private carrier, through a state fund, or by self-insuring, depending on applicable state regulations.

In Texas, employers are not required to purchase workers' compensation insurance.[23] However, those who do not participate forgo assumed immunity against negligence. In 2001, 35 percent of year-round employers did not provide WC coverage to some 1.4 million employees, or about 16 percent of the workforce. Non-participation was highest among employees in the retail trade (48 percent), service sector (38 percent), and manufacturing sectors (36 percent).[24] Companies providing WC insurance most often cited company philosophy, fear of legal action, and requirements for obtaining state contracts as the reason for providing WC coverage.[25] Those not providing coverage cited high costs, too few employees or injuries, better alternatives, and a desire for more control over medical provider as primary reasons.[26]

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[22] Worrall JD (1983). Compensation costs, injury rates, and the labor market. Safety and the Work Force. Worrall JD. Ithaca, NY, ILR Press: 1-17.
[23] Shields J and Campbell DC. A study of non-subscription to the Texas Workers' Compensation System. Research and Oversight Council. Austin February 2002:
[24] *Ibid.*
[25] *Ibid.*
[26] *Ibid.*

There is no state administered WC fund in Texas per se, but the State of Texas operates an insurer of last resort. In 2001, Texas re-configured the state WC fund into an independently managed, competitive insurer called the Texas Mutual Insurance Company. Texas Mutual Insurance Company is the state's largest underwriter of WC claims and offers coverage to all employers in the state. However, it also serves as an insurer of last resort for companies that are unable to obtain affordable coverage from competing firms or may lack a sufficient risk history. Rates for the Texas Mutual Insurance Company, like rates for all insurance companies doing business in the State of Texas, are submitted to the Texas Department of Insurance to determine if they are fair and adequate.

1.4. Workers' Compensation in Texas

The Texas Workers' Compensation Commission (TWCC) regulates current workers' compensation policies and regulations. The 71st Texas State Legislature established the commission, which came into existence on April 1, 1990. Its legal authority, mandate, and general duties are described in Chapter 402 of the Texas Workers' Compensation Act. Some primary responsibilities covered by the Act include promoting safe and healthy workplaces, providing information on rights and responsibilities of employers, resolving disputes efficiently and effectively without going to court, certifying workers' compensation insurers (including self-insured plans), and ensuring compliance with TWCC rules and regulations.[27]

Of particular relevance to this project are the dual mandates of ensuring injured employers receive efficient, timely, and appropriate health care and that providers are reimbursed a reasonable fee for providing health services.[28] During the 77th legislature, these mandates were extended by passage of House Bill 2600. Included in this bill were provisions to address rising WC costs, including the review of healthcare monitoring and health delivery networks.[29] Since then, and following the 78th legislative session, a new mission statement is being proposed that emphasizes the Commission's role in the promotion of quality healthcare resources and services to injured workers.

Of the 16 articles in this bill, articles 1-3 directly address quality of care and financial issues associated with WC in Texas.[30] Article 1 amended the labor code to require that each physician who is approved to provide WC care must meet tighter eligibility criteria. Prior to HB 2600, all physicians licensed in the state of Texas were eligible to be on the TWCC approved doctors list if they registered and complied with TWCC rules. Article 1 requires TWCC to establish methods for approving doctors to provide WC care.[31]

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[27] Texas Workers' Compensation Commission. Agency Strategic Plan for Fiscal Year 2003 - 2007. Texas Workers' Compensation Commission. Austin, TX June, 2002.
[28] *Ibid.*
[29] *Ibid*.
[30] Office of House Bill Analysis, Texas State Legislature. Analysis of H.B. 2600, 77th Regular Legislature. July 27, 2001. Available: www.capitol.state.tx.us. Accessed: January 24, 2004.
[31] *Ibid*.

Article 2 of HB 2600 required that TWCC establish the Health Care Network Advisory Committee to advise TWCC on the need and feasibility of establishing regional fee-for-service health delivery networks. Such networks would be designed to improve health outcomes while also reducing costs associated with injury treatment.[32] Furthermore, this bill requires TWCC administrators to determine annual costs savings to the WC system due to network implementation. Article 3 encourages timely return to work (RTW) by establishing provisions for an employer to provide modified RTW programs for injured workers, including assessment of worksites for possible job modification.[33] Overall, HB 2600 is expected to produce $50 million in total savings over six years.[34]

Six commissioners appointed by the governor, who in turn collectively appoint an executive director, govern TWCC. Three commissioners are chosen to represent workers' interests and three are chosen to represent employers' interests. A chair is appointed on a rotating basis between the two groups. The Texas Business and Industry Data Center reports approximately 9.4 million Texans were employed on a seasonally adjusted basis during 2003, thus representing 9.4 million potential covered lives under the state's WC mandate.[35]

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[32] Office of House Bill Analysis, Texas State Legislature. Analysis of H.B. 2600, 77th Regular Legislature. July 27, 2001. Available: www.capitol.state.tx.us. Accessed: January 24, 2004.
[33] *Ibid.*
[34] Legislative Budget Board, Texas State Legislature. Fiscal Note of H.B. 2600, 77th Regular Legislature. May 19, 2001. Available: www.capitol.state.tx.us. Accessed: January 24, 2004.
[35] Business and Industry Data Center, State of Texas. Labor Market Information. Available at: www.bidc.state.tx.us. Accessed: December 12, 2003.

1.5. Development of the Workers' Compensation Structure

Until the introduction of managed care in the 1980s, most health insurance companies used a fee for service (FFS) model to pay claims. Under this model, physicians and other health care providers were reimbursed for usual and customary expenses for services rendered. Little attempt, if any, was made to negotiate prices or measure quality of services rendered. Workers' compensation operated in a similar manner. That is, WC insurance typically acted as passive payer and left treatment decisions to the individual physician.[36] In addition, few attempts were made to measure quality of care using currently accepted benchmarks such as return to work time, employee satisfaction, and return to normal functional status.

Average costs for WC care nationally began to increase rapidly between 1980 and 1993. During this time period, the average annual increase in WC health care expenditure was 13 percent per annum,[37] which outpaced the 10 percent yearly increase in national health expenditure during that time period. From 1981 – 1991, the portion of total WC health expenditure due to hospitalization costs increased from 30 to 40 percent.[38] Costs associated with workers' compensation were the largest single labor cost behind wages[39] To control these escalating health costs, innovative health care management strategies were introduced to WC.

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[36] Nikolaj S and Boon B. Health care management in workers' compensation. *Occupational Medicine* 1998;13(2):357-379.
[37] *Ibid.*
[38] *Ibid.*
[39] Shor MJ and Miller JC. The role of managed care in work-related injuries. *Orthopedic Clinics of North America* 1996;27(4):711-721.

1.5.1. Health Care Management Strategies in Workers' Compensation

According to Nikolaj and Boon, a number of strategies have been introduced to reduce WC health-related costs.[40] Early strategies focused on reducing WC health-related expenditures. Over time, management strategies evolved from a cost-containment approach to a cost-effectiveness approach, focusing on a combination of reduced expenditure, increased quality, improved health outcomes, and increased patient, employer, and provider satisfaction.

1.5.1.1. Cost Containment Strategies

An early cost-containment initiative to reduce WC health expenditure was the introduction of fee schedules. The primary aim of fee schedules was to reduce the amount of money spent to cover a particular service. Typically these fees were not negotiated, thus creating antipathy among providers. In turn, providers could refuse to offer services within the WC system or could compensate for reduced fees by increasing utilization.

Three studies have reviewed the impact of fee schedules on holding down WC health costs. Of these three studies, one showed a decrease in WC medical costs,[41] one was inconclusive,[42] and a third indicated that providers found ways to maintain their income

[40] Nikolaj S and Boon B. Health care management in workers' compensation. *Occupational Medicine* 1998;13(2):357-379.
[41] Durbin D, Appel D. The impact of fee schedules and employer choice of physician. *NCCI Digest* 1991;6(3):45-47.
[42] Boden LI, Fleischman CA. Medical costs in workers' compensation: trends in interstate comparisons. Cambridge, MA. Workers' Compensation Research Institute. 1989.

in spite of reduced fees (e.g., provided more complex procedures that allowed for greater remuneration).[43] Anecdotal evidence from a single physician practice reported that service over-utilization may occur to compensate for reduced service fees.[44] Other processes aimed at reducing WC health-related expenditure included: medical billing review, capitation, case rates, and volume discounts.[45]

1.5.1.2. Managed Care Strategies

Beginning in the 1980s, health insurance companies in the United States began moving away from FFS and simplistic cost containment strategies (e.g., fee schedules) in favor of a managed care approach. This new approach was generally based more on cost-effectiveness and evidence-based best practice than the previous cost control based approach. Indeed, managed care has been described as a mechanism to achieve optimal health outcomes at a reasonable cost.[46] Following this initiative, workers' compensation programs also began relying more on managed care as a means to improve health and quality while ensuring that the most appropriate, effective type of treatment was provided. There are two primary models of WC managed care. The first model, mandated managed care, requires injured workers to use a managed care arrangement for

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[43] Pozzebon S. Do traditional health care cost containment practices really work? *John Burton's Workers' Compensation Monitor* 1993;6(9):17-22.
[44] Miller LA. Networks in workers' compensation medical delivery. *Occupational Medicine* 1998;13(4):717-725.
[45] Nikolaj S and Boon B. Health care management in workers' compensation. *Occupational Medicine* 1998;13(2):357-379.
[46] Shor MJ and Miller JC. The role of managed care in work-related injuries. *Orthopedic Clinics of North America* 1996;27(4):711-721.

treatment of work-related injuries.[47] In the second, regulated managed care, state governments define elements of managed care via the legislative process.[48]

1.5.1.2.1. Preferred Providers

An essential element of managed care is identifying, selecting, and pre-approving physicians to be providers. Initial attempts to develop preferred provider networks were based on limiting provider choice to a select group of individuals who contracted with the WC insurance plan – a move initiated to reduce costs. Subsequent methods have considered a more sophisticated approach that includes selecting the best provider(s) in a region, providing fair compensation, defining service expectations, using evidence-based practice guidelines, and defining employee and employer expectations.

1.5.1.2.2. Case Management

Case management provides assistance to the injured employee through coordinated care. The case manager, who is typically a registered nurse, keeps in close contact with the patient, coordinates disparate care, and becomes an advocate for the injured worker. Ideally, the case manager should participate at the earliest stages of the injury in order to best serve the needs of the injured worker. Components of a good case management system include: early intervention, patient assessment (of both physical and

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[47] Nikolaj S and Boon B. Health care management in workers' compensation. *Occupational Medicine* 1998;13(2):357-379.
[48] *Ibid.*

psychological needs), appropriate referral, employer and physician contact, care coordination, and assessment and facilitation of return to work options.[49]

1.5.1.2.3. Quality Assurance

Workers' compensation insurers recognize that focusing on cost alone is not sufficient to achieve improved patient outcomes. In order to ensure that workers are receiving appropriate care that encourages timely return to work, quality indicators or benchmarks are necessary to measure the effectiveness of care delivered. Interestingly, it is the proliferation of preferred provider networks that has enhanced managed care's ability to initiate quality assurance programs. These programs range from the simple to the complex, but typically focus on accessibility, appropriateness, efficiency, and effectiveness. Specific benchmarks may include: physician credentials (e.g., board certification, licensure status, number of malpractice lawsuits or awards), timeliness and friendliness of access to care, comparison of patient outcomes to established norms, and patient satisfaction.

Three types of quality assurance variables can be assessed: (1) input variables; (2) process variables; and (3) outcome variables.[50] Input variables provide baseline data on which to make future comparisons and include demographic, billing, and clinical data. Process variables are concerned with how care is delivered and include items like fee

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[49] Brain GF and Conlon M. The case management approach to work-related injuries. *Orthopedic Clinics of North America* 1996;27(4):831-840.
[50] Nikolaj S and Boon B. Health care management in workers' compensation. *Occupational Medicine* 1998;13(2):357-379.

schedules, time to complete specific activities (e.g., time to first appointment, referral, or service completion), and adherence to clinical guidelines. Outcome variables measure the effect of the intervention and the success of a provider or treatment. Typical outcome variables include: return to work (RTW) status; clinical and functional improvement; ability to maintain RTW status; types, quantity, and cost of health service utilization; wage loss and indemnity costs; and employee, employer, and physician satisfaction.

Accreditation from an outside provider organization is another type of quality assurance indicator. Many of these organizations accredit facilities (e.g., the Joint Commission on Accreditation of Healthcare Organizations and National Council on Quality Assurance). Yet while not directly certifying providers, these organizations define acceptable standards for facilities in which a provider may treat patients (e.g., hospitals, rehabilitation clinics, etc.), thus removing the need for WC programs to maintain individual evaluation processes for these facilities.

1.5.1.2.4. Networks

Networks have long played an important role in medical care. Examples of early networks include scientific societies, teaching institutions, and non-profit organizations.[51] With the advent of managed care, networks were used to negotiate relationships between

[51] Miller LA. Networks in workers' compensation medical delivery. *Occupational Medicine* 1998;13(4):717-725.

purchasers and providers based on price.[52] As quality assurance has gained stature, networks have become important vehicles for managing disability and indemnity care.

Many aspects of network development in WC are the same as those in managed care described above. However, an additional driver unique to network development in WC is employer control of the disposition of the case. This means that payers wanted to ensure that injured workers received the most appropriate care from the most appropriate provider. In essence, the ability to restrain total costs could be achieved by directing care to those who had the experience and knowledge of treating occupational injuries, who have experience with workers' compensation reporting requirements, and who could provide an objective assessment of true injury disability.[53] Over time, it appears that many of the founding features of networks (e.g., wanting injured workers to receive the most appropriate care from the most appropriate provider) have become foundations for the disability management model.

Networks have the advantage of restricting the number of providers available and can help control expenditure by increasing volume for those providers in the network while reducing patient volume for those outside the network.[54] In addition, managed care plans can negotiate lower medical service fees from providers. Another important aspect of restricting the number of providers is reduced administration costs. For example, there

[52] *Ibid.*
[53] *Ibid.*
[54] Peele PB and Tollerud D. Managed care in workers' compensation plans *Annual review of public health* 2001;22(1):1-13.

are fewer physicians to manage (i.e., for quality control, utilization review, and contracting purposes) and fewer billing management costs. Restricted plans are also able to ensure adequate standards of care.

1.5.1.3. Disability Management Model

Workers' compensation programs and insurers embraced managed care in the 1990s as a way to decrease health-related expenditures and improve treatment outcomes for injured workers. Beyond the traditional managed care approach however, was the realization that at risk workers returning to full, productive careers, required an interdisciplinary approach to care management. This interdisciplinary approach, termed the disability management model (DMM) and sometimes referred to as the occupational medicine model, is a integrated approach to managing an injured worker's disability. The DMM "represents a worksite-based approach to early intervention, the goals of which include prevention of chronic and progressive disability, effective return-to-work outcomes, and employment retention of workers with disabilities."[55]

However, disability involves complex variables and is not predictable for a specific injury. Also, the assignment of impairment ratings can vary somewhat from provider to provider.[56] In fact, disability management often reflects a process of negotiation between

[55] Shrey DE. Worksite disability management model for effective return-to-work planning. *Occupational Medicine* 2000;15(4):789-801.
[56] Smith PJ and Preis I. A systematic approach to provider based disability management. *Hawaii Medical Journal* 2001;60(12):318-320.

the provider and injured worker.[57] Disability divergence, which occurs when the physician's perception of patient disability differs from the patient's, can reinforce the perception of injury among the patient, with the ultimate effect of longer disability and higher costs.[58] However, regardless of whether disability is constant for a specific injury or how providers assign impairment, the earlier an injury is reported, the sooner the disability management model can be implemented.

1.5.1.3.1. Early Injury Reporting

Reporting an injury early is essential to early treatment, rehabilitation, and return to work. Conversely, delayed injury reporting may be a source of uncontrolled lost time. Most injuries are reported 7-10 days after occurrence. Once an injury is reported and medical consultation provided, the employer should determine the lost time impact of the injury by contacting the physician. In discussion with the provider, the employer should determine the extent of the injury, specific work restrictions, available functional abilities, and a likely return-to-work (RTW) date. The employer will use this information to develop the injured worker's RTW plan.

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[57] *Ibid.*
[58] *Ibid.*

1.5.1.3.2. Return-to-Work Assessment and Planning

Companies should have an established RTW plan as part of company policy. This plan will describe steps involved in initiating the RTW process. The purpose of this plan is to encourage workers and their employers to accept the worker's injury and allow him to participate in work duties appropriate for the injury with an eventual aim of returning to full, productive work status when the injury is healed.

Simple injuries expected to heal in a short period of time (e.g., lacerations, contusions, minor strains) that will likely result in full recovery do not require the formality of a RTW plan. Complicated injuries (e.g., sprains and strains with greater than two weeks lost time from work) may take longer to heal and are candidates for the RTW plan. Additional criteria for defining which injuries to include in the RTW plan include: an actual or expected absence from work for at least 30 days due to the injury; the worker's job is at risk; and the current light duty assignment has exceeded predicted lost time expectations.[59]

The goal of the RTW plan is to return an injured worker to a full productive job. The first step is for the case manager to conduct a work ability evaluation in order to build a relationship with the injured worker and to provide an RTW assessment. According to Shrey, the RTW assessment is essential to a comprehensive disability management plan

[59] Shrey DE. Worksite disability management model for effective return-to-work planning. *Occupational Medicine* 2000;15(4):789-801.

and should include evaluations of functional capacity and job / workplace assessments.[60] The RTW assessment includes obtaining information from the worker about his education and vocational background, work history, transferable work skills, typical daily activities, personal perspectives on treatment, current relationship and work status with his supervisor, and potential accommodation needs.[61] If the worker is deemed capable of returning to work after assessment, an RTW plan should be developed. This plan will identify options that will enable the worker to RTW, including: reducing work barriers, providing accommodations, or return to a similar job within the work unit or department.

1.5.1.4. Role of Occupational Medicine and Industrial Hygiene

The evolution of managed care (MC) from a cost-control to a cost-effectiveness model highlights the role, and need, of occupational medicine and industrial hygiene in treating injured workers, improving outcomes, and improving RTW rates. Despite the lack of a clearly delineated model of how best to use occupational medicine and industrial hygiene, MC models have successfully integrated occupational physicians, nurses, and industrial hygienists in a comprehensive effort to manage occupational injuries. One such model is the Johns Hopkins Workers' Compensation plan established at the Johns Hopkins Medical Center in Baltimore, MD. This self-insured preferred provider organization takes advantage of in-house network of occupational physicians coupled

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[60] *Ibid.*
[61] *Ibid.*

with occupational nurses and other ancillary staff to manage and treat injured workers, identify and remove workplace hazards, and encourage timely return to work.

1.6. Summary

Today's workers' compensation system evolved over the last 200 years. In its infancy, it merely represented a means for employees to receive compensation and treatment for injuries sustained at work, while reducing liability of the employer. Today, WC has emerged as a proactive system seeking to manage injuries and return injured employees to work using a comprehensive, evidence-based approach. Interestingly, the evolving nature of WC care during the last 25 years is largely due to the need to reduce WC expenditure and hold down costs. WC costs, like healthcare costs in general, have exhibited exorbitant increases over the past 25 years. In the rush to contain costs, quality control emerged as an important component and received considerable attention from state regulators, insurers, employers, and employees. The next section identifies and analyzes empiric studies reviewing the effect of quality initiatives on WC health outcomes and expenditures. In particular, the next section will look at the impact of managed care concepts including networks, quality benchmarks, and disability management on WC health outcomes and expenditures.

2. Literature Review

2.1. Introduction

This section reviews and discusses research studies involving workers' compensation (WC) delivery models. In particular, it critically reviews outcomes associated with WC managed care (MC) models vs. WC fee for service (FFS) models. It also assesses the costs and characteristics associated with patients and physicians who receive or provide treatment under WC. Items covered in the one-page summary include:

- Study objectives
- Study design
  - Type of study
  - Setting
  - Time period
  - Population characteristics (e.g., size, mean age, gender, race)
  - Inclusion criteria
  - Additional details of the study (e.g., background information)
- Main findings
  - Specific study findings
  - Comparisons
  - Results of statistical analyses
- Conclusion
  - Summary of the authors' conclusions
  - Additional interpretation, if warranted
  - Study limitations

2.2. Materials and Methods

Studies included in this section were identified by searching five primary databases: (1) Medline; (2) International Pharmaceutical Abstracts; (3) Cumulative Index to Nursing and Allied Health (CINAHL); (4) EconLit; and (5) Dissertations Abstracts. Secondary searches were carried out at specific government websites (e.g., Washington State Department of Labor and Industries), libraries, and through manual searches of reference lists in retrieved articles and other publications. Empiric studies on workers' compensation (i.e., randomized controlled trials, cohort studies, case-control studies, cross-sectional studies, data analytic studies, or surveys) related to the objectives of this project were reviewed. Background articles, discussed in the introduction, were not analyzed in this section.

2.3. Results

Thirty-two studies met the inclusion criteria and are included in this literature review. These articles compared specific attributes of MC to FFS, reported outcomes and satisfaction measures in WC care generally, compared outcomes among MC and FFS models, and reported on geographic differences in WC utilization and charges. Some studies reported results from the Johns Hopkins University Workers' Compensation Managed Care Pilot Program and others reported findings associated with the Washington State Managed Care Pilot Program. The studies used data obtained from surveys, nationally available databases, observations associated with interventions. Appendix A provides details of each study in this literature review.

Despite the focus on managed care activities in general, not all managed care activities are homogenous. For example, as noted in the introduction, the concept of managed care has evolved over time from a cost-control to a cost-effectiveness model. There are also differences in how cost-effectiveness objectives are attained. Some programs may rely on utilization and case management activities to increase cost-effectiveness while others may rely on an occupational medicine model stressing return-to-work (RTW), accommodation, and industrial hygiene. Therefore, the reader should not assume all managed care activities are the same. When appropriate, specific types of managed care are differentiated from one another and are noted in this literature review.

Eight themes of WC outcomes and expenditure were identified in the literature review:

1. Satisfaction outcomes
2. Specific injury outcomes
3. Rehabilitation and accommodation characteristics
4. Service utilization and intervention patterns
5. Medical, indemnity, and other cost outcomes
6. Return-to-work characteristics
7. Time loss characteristics
8. Geographic characteristics

2.3.1. Satisfaction Outcomes

Treatment satisfaction is a key outcome measure in determining if a particular WC program meets the needs of injured workers, their employers, and healthcare providers. Four studies assessed satisfaction outcomes.

2.3.1.1. Employer Satisfaction with WC Managed Care

One of the earliest studies assessing employer satisfaction with WC managed care comes from the Washington State Workers' Compensation Managed Care Pilot. This pilot program emphasized an occupational medicine model of physician-employer communication regarding medical treatment, time loss status, job modification, and RTW expectations. There were two arms to this pilot project: (1) a managed care arm that treated patients using the occupational medicine model and reimbursed physicians on an experience-rated capitation system; and (2) a control arm that treated patients in the standard manner and reimbursed physicians on a FFS basis.

Kyes *et al.* reported that employers in the MC arm were more satisfied than employers in the control arm.[62] Based on inclusion criteria requiring at least one work-related injury during the evaluation period, 97 firms had employees in the MC arm and 146 had employees in the control arm. Employers using MC reported higher satisfaction ratings

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[62] Kyes KB, Wickizer TM and Franklin G. Employer satisfaction with workers' compensation health care: results of the Washington State Workers' Compensation Managed Care Pilot. *Journal of Occupational and Environmental Medicine* 2003;45(3):234-240.

than control clinics for provision of medical treatment ($p < 0.05$) and for receiving treatment information ($p < 0.01$). Compared to control clinics, more clinics using the MC model were rated excellent in returning injured employees to work (63 percent vs. 35 percent, $p < 0.01$) and for providing higher quality information on time loss to employers. MC clinics were better able to accommodate the needs of returning injured workers than control clinics. For example, MC clinics were more likely to report placing an injured worker on modified work duty (30 percent vs. 18 percent, $p = 0.07$) and were less likely to find it difficult to make an accommodation (5 percent vs. 14 percent, $p = 0.06$); however, in both comparisons the percentages were not significantly different. In addition, a greater proportion of employers who used MC found claims processing better as judged by the response "excellent" (37 percent vs. 22 percent, $p < 0.01$).

2.3.1.2. Employee Satisfaction with WC Managed Care

In a separate study under the Washington State WC Managed Care Pilot Program, Kyes *et al.* reported employee satisfaction results at six weeks (N=1,302) and six months (N=372) post-injury.[63] Results showed "little meaningful difference between the managed-care and FFS patients in any of the [satisfaction] measures at 6 weeks [with regard to medical outcomes], although the difference in overall assessment of treatment outcome (0.2 on a five-point scale) was statistically significant ($p < 0.01$)."[64] However, this difference, albeit slight, favored the control (FFS) group (3.7 vs. 3.5, $p < 0.01$). At

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[63] Kyes KB, Wickizer TM, Franklin G*, et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project I: medical outcomes and patient satisfaction. *Medical Care* 1999;37(10):972-981.
[64] *Ibid.*

six months, the control (FFS) group retained a higher overall medical outcome assessment (3.5 vs. 3.3, p = NS) than the managed care group but this difference was not significant.

This study also reported that patient satisfaction was significantly higher in the control group than the managed care group at six weeks (51 percent vs. 47 percent, $p < 0.01$) but not at six months (41 percent vs. 40 percent, p = NS). However, at six months, satisfaction ratings with overall access to care (44 percent vs. 30 percent, $p < 0.05$), choice of attending physician (82 percent vs. 69 percent, $p < 0.01$), and access to specialists (67 percent vs. 59 percent, $p < 0.01$) were significantly higher in the control group. The authors note that while there is "no consistent pattern of significant difference" between the two groups (as judged by the overall non-significant satisfaction rating between the two), low statistical power in the sample does not allow them to rule out actual differences that might have been detected with a larger sample size.[65]

In a similar study, Feuerstein *et al.* assessed patient satisfaction for injured workers in an integrated case management (ICM) program.[66] Similar to the Washington State program, the ICM model concentrated on medical management, the work environment, and the claims process. This study of 131 federal civilian workers with work-related upper extremity disorders assessed satisfaction by asking 13 questions. Overall, ICM patients

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[65] Kyes KB, Wickizer TM, Franklin G*, et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project I: medical outcomes and patient satisfaction. *Medical Care* 1999;37(10):972-981.
[66] Feuerstein M, Huang GD, Ortiz JM*, et al.* Integrated case management for work-related upper-extremity disorders: impact of patient satisfaction on health and work status. *Journal of Occupational and Environmental Medicine* 2003;45(8):803-812.

had higher total patient satisfaction than usual care patients (score of 55.9 vs. 41.3, $p < 0.01$).

The degree to which physicians provided "proactive" care influenced workers' perceptions of their medical care. In 2001, Dasinger *et al.* reported results from a retrospective survey assessing the extent that physician communication skills on aspects of work (e.g., the workers' job, injury information, and specific work restrictions) impact RTW status.[67] The effects of acute care physician (PTP-1 – the physician who managed the first thirty days of the injury) and chronic care physician (PTP-2 – the physician who managed care for days 31-90) communication ability were assessed separately. A majority of respondents (> 60 percent) reported that PTP-1 and PTP-2 physicians talked with them some or a lot about their job activities, seemed to understand fairly or very well their job responsibilities, and suggested how they could change their work activities to prevent re-injury. Due to the potential for recall bias (i.e., up to three years post-injury), a patient's ultimate outcome may have influenced their perceptions of physician communication ability.

In a sample of 813 injured workers in Northern California assessing WC in general, 76.5 percent (N=619) of respondents reported being somewhat satisfied or very satisfied with

[67] Dasinger LK, Krause N, Thompson PJ, Brand RJ and Rudolph L. Doctor proactive communication, return-to-work recommendation, and duration of disability after a workers' compensation low back injury. *Journal of Occupational and Environmental Medicine* 2001;43(6):515-525.

medical care while 23.5 percent (N=190) reported being somewhat dissatisfied or dissatisfied with medical care.[68] Statistical significance levels were not reported.

2.3.1.3. Summary

Results from studies assessing employee satisfaction with WC managed care are equivocal, and most likely represent a combination of factors including sample size, sample characteristics, and type of WC managed care services offered. The Washington State WC managed care plan, on the whole, showed greater satisfaction than FFS plans among employers (but this was not statistically significant) and similar satisfaction among employees. Employers reported higher satisfaction ratings for returning injured employees to work and for providing higher quality information on loss time about employees. For employees, satisfaction was statistically higher for FFS at six weeks, but not at six months. This may indicate that for illnesses of short duration, patients prefer FFS care, but for illnesses lasting at least six months either FFS or MC provides a similar level of patient satisfaction. The only other study that looked at a WC intervention assessed integrated case management (ICM) and found that patients preferred ICM to standard care.

[68] Rudolph L, Dervin K, Cheadle A, Maizlish N and Wickizer T. What do injured workers think about their medical care and outcomes after work injury? *Journal of Occupational and Environmental Medicine* 2002;44(5):425-434.

2.3.2. Specific Injury Outcomes

Seven studies reviewed aspects of workers' compensation care for specific injuries, surgeries, and illnesses.

One study reviewed the effect of utilization management (UM) in reducing workers' compensation expenditure.[69] In this study, UM consisted of three main activities: (1) pre-admission review, (2) concurrent review; and (3) case management. Results showed that 1/3 of injured workers seeking inpatient hernia repair were required to have it done as an outpatient (OP). Interestingly, 66.6 percent (N=30) of patients denied OP treatment were subsequently approved for OP treatment during case review. Fifty-one percent of those approvals were for carpal tunnel syndrome and 12 percent were for arthroscopic surgery. For inpatient care, 59.8 percent (N=79) of all denied cases were for spinal surgery.

Cheadle *et al.* analyzed 28,743 injury claims from Washington State occurring from 1987 to 1989.[70] The most commonly reported injury in this study was back sprain (34 percent) followed by "other" sprains and strains (20 percent). Mean duration of disability ranged from a high of 159.9 days for workers with carpal tunnel syndrome to a low of 110.4 days for "other" sprain. Back and neck sprain, on average, had a mean disability duration of 145.6 days while fracture had a mean duration of disability of 110.4 days.

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[69] Wickizer TM, Lessler D and Franklin G. Controlling workers' compensation medical care use and costs through utilization management. *Journal of Occupational and Environmental Medicine* 1999;41(8):625-631.
[70] Cheadle A, Franklin G, Wolfhagen C*, et al.* Factors influencing the duration of work-related disability: a population-based study of Washington State workers' compensation. *American Journal of Public Health* 1994;84(2):190-196.

In 1998, Bernacki and Guidera analyzed surgical procedure claims for two cohorts: (1) a pre-disability management cohort using data from 1990 to 1992; and (2) a post-disability management cohort using data from 1993 to 1997.[71] The number of employees covered by this WC disability management program increased by 6,500 from 1990 to 1997 while the number of surgical claims decreased from 152 in 1993 to 101 in 1997. Surgical rates were significantly lower under managed care from 1995 to 1997 than during the last full year (1992) of pre-disability management (all $p < 0.05$). Absolute numbers of surgeries for 12, 24, and 36 months post-injury decreased under disability management vs. pre-disability management. However, surgical frequency for repetitive trauma or traumatic nerve entrapment increased at month 36 under managed care. Like Wickizer *et al.*,[72] this study showed a decrease in spinal surgery after the introduction of managed care (15 vs. 3 procedures). This study did not consider potential confounding factors (e.g., age, gender, comorbidity, type of injury, etc.).

Data from 126,989 work-related injury claims analyzed from an administrative database using data from 24 states showed a decrease in the number of certain procedures over a three-year period.[73] From 1997 – 1999, there was a 16 percent decrease in hospitalizations for work-related disc and spinal injuries and a corresponding 30 percent decrease in inpatient laminectomy. There were also 16 percent fewer knee arthroscopies

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[71] Bernacki EJ and Guidera JA. The effect of managed care on surgical rates among individuals filing for Workers' Compensation. *Journal of Occupational and Environmental Medicine* 1998;40(7):623-631.
[72] Wickizer TM, Lessler D and Franklin G. Controlling workers' compensation medical care use and costs through utilization management. *Journal of Occupational and Environmental Medicine* 1999;41(8):625-631.
[73] Dembe AE, Mastroberti MA, Fox SE, Bigelow C and Banks SM. Inpatient hospital care for work-related injuries and illnesses. *American Journal of Industrial Medicine* 2003;44(4):331-342.

and 25 percent fewer hospitalizations for sprain / strain. This study did not compare payer type – it simply reported on trends within WC in general, although it is likely that some decrease in utilization could be due to trends in WC managed care. However, it should be noted that during this same time period treatment guidelines and studies showed that conservative treatment had similar outcomes as with surgery for lower spine disc disease. Therefore, while MC may have played a role in reducing surgery and encouraging conservative treatment, it was not the only influence. Data on which of the 24 states are involved in WC managed activities is not available.

Results assessing New Zealand's workers' compensation RTW assessment procedure indicated that 59 percent (N=79) of respondents suffered from a back injury, 39 percent (N=55) had an arm injury, and 25.5 percent (N=36) had neck injuries.[74] In a separate article by Linz *et al*, 608 injured workers, of whom 589 had a final diagnosis, reported the five following most common diagnoses: open finger wound (N=90, 15.2 percent), lumbar sprain or strain (N=62, 10.5 percent), lumbo-sacral sprain or strain (N=62, 10.5 percent), cornea abrasion (N=32, 5.4 percent), and foreign body abrasion (N=32, 5.4 percent).[75] In a study from New South Wales, Australia, similar injury findings were reported.[76] For example, of 1,289 WC reported cases 86 percent were for sprain / strain.

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[74] Christian B. Return to work outcomes following accident compensation corporation work capacity assessment. *New Zealand Medical Journal* 2002;115(1153):209-211.
[75] Linz DH, Ford LF, Nightingale MJ*, et al.* Care management of work injuries: results of a 1-year pilot outcome assurance program. *Journal of Occupational and Environmental Medicine* 2001;43(11):959-968.
[76] Tuchin PJ and Bonello R. Preliminary findings of analysis of chiropractic utilization and cost in the workers' compensation system of New South Wales, Australia. *Journal of Manipulative and Physiological Therapeutics* 1995;18(8):503-511.

Of these, 57 percent were for the lower back, 13 percent were for the trunk, and 10 percent were for upper limbs.

2.3.2.1. Summary

Several studies provided incidence data on commonly reported WC injuries. The most commonly reported include back sprain / strain, arm injury, neck injury, and carpal tunnel injury. It is difficult to make meaningful comparisons between studies as the populations and data collection methods are different.

2.3.3. Rehabilitation and Accommodation Characteristics

An essential component of disability management is worker rehabilitation and accommodation. Rehabilitation seeks to restore a worker to his or her pre-injury status while accommodation seeks to modify an existing job so an injured work may continue working during the healing process. Three studies reviewed accommodation and rehabilitation outcomes in WC managed care.

2.3.3.1. Rehabilitation

In a 2003 study from Sweden, the possible beneficial effects of early rehabilitation were assessed in 137 injured workers.[77] Sixty-five workers were in the intervention group and 72 were in the control group. Details of the intervention group are available in the Appendix , but briefly, the injured workers were interviewed, had their workplace assessed, and underwent vocational training and rehabilitation as appropriate. Employers also conducted rehabilitation interventions. Results showed that intervention group (IG) employers took less time to complete their rehabilitative investigation than control group (CG) employers (59.4 vs. 126.8 days, p < 0.01). In addition, it took the workers compensation bureau (i.e., the Försäkringskassan, or FK) less time to develop a patient rehabilitation plan for IG employees than for CG employees (49.4 vs. 183.5 days) and less time to initiate a vocational intervention for IG employees than for CG employees (88.1 vs. 190.7 days, p < 0.01). In addition, workers in the IG were more likely than CG workers to have returned to work at 12 months (RR: 2.5; 95 percent CI: 1.2 – 5.1; p < 0.01).

In a study of 3,401 workers from New South Wales, Australia, Kenny conducted a retrospective analysis and found that 8 percent of workers received rehabilitation from an accredited provider.[78] She also found that these workers, on average, had a mean of 3.33

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[77] Arnetz BB, Sjögren B, Rydèhn B and Meisel R. Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study. *Journal of Occupational and Environmental Medicine* 2003;45(5):499-506.
[78] Kenny D. Determinants of time lost from workplace injuries: the impact of the injury, the injured, the industry, the intervention and the insurer. *International Journal of Rehabilitation Research* 1994;17(4):333-342.

fewer weeks off from work than all other workers, controlling for the nature of injury. This indicates that rehabilitation is associated with positive RTW outcomes. The results also revealed that for every $1,000 spent on rehabilitation, six weeks additional time is lost from work, controlling for injury factors. The correlation between extra money spent on rehabilitation and additional time off may simply be a proxy for severity, with more severe conditions needing more rehabilitation, costing more money, and requiring more time for recuperation.

2.3.3.2. Accommodation

In an article by Lincoln *et al*., 101 injured workers (N=53 for the intervention group and 48 for the control group) were assessed by nurses trained in integrated case management (ICM).[79] The purpose of this study was to determine if ICM-trained nurses provided better care to injured workers with regard to workplace accommodation than nurses non-trained in ICM. ICM-trained nurses received 16 hours of training in how to conduct ergonomic assessments, implement workplace accommodations, and reduce RTW barriers. In total, 208 accommodations were recommended and 74.5 percent (N=155) were implemented in this prospective randomized controlled investigation.

ICM-trained nurses recommended more accommodations than nurses not trained in ICM (2.43 vs. 1.63; $p < 0.01$), were more likely to have accommodations implemented (1.81

[79] Lincoln AE, Feuerstein M, Shaw WS and Miller V. Impact of case manager training on worksite accommodations in workers' compensation claimants with upper extremity disorders. *Journal of Occupational and Environmental Medicine* 2002;44(3):237-245.

vs. 1.25; $p < 0.05$), and were more likely to recommend multiple accommodations to clients. The most common types of recommended accommodation were: administrative in nature (55 percent), modified or light duty (22.1 percent), and lifting restrictions (16.4 percent). There were differences among the type of accommodation offered between the two groups. ICM nurses were more likely to recommend seating, posture, workspace, or computer modifications. Administrative accommodations were more likely to be suggested by nurses not trained in ICM (73 percent vs. 43 percent; $p < 0.001$). This suggests that ICM training impacted not only the quantity of accommodations offered, but also the type offered. It also suggests that ICM-trained nurses have a better knowledge of the breadth of potential accommodations (e.g., ergonomic adjustments) than nurses without this training and feel confident in making these recommendations.

2.3.3.3. Summary

Two studies assessed the effect of rehabilitation on helping injured employees return to work. Both studies showed that injured workers receiving rehabilitation either had less time off work than controls or were more likely to return to work by 12 months than controls. Accommodation was assessed by one study and found that nurses trained on accommodation procedures were more like to suggest appropriate accommodations and have those accommodations implemented, thus returning injured employees to work sooner.

2.3.4. Service Intervention and Utilization Patterns

Providing appropriate interventions and assessing the results from these interventions are cornerstones of managed care WC programs. As such, empiric research seeks to identify changes in service utilization and intervention after managed care programs are introduced. Six studies described changes in service utilization and intervention after implementing WC managed care.

In a study of 11,785 patients with 9,319 reviews, the effect of utilization management on service utilization was assessed.[80] Reductions in utilization occurred in both inpatient and outpatient populations. For example, 2.1 percent (N=132) of pre-admission inpatient requests were denied and 2.7 percent (N=148) of outpatient requests were denied. Additionally, 4.6 percent (N=286) of patients seeking inpatient treatment were authorized to receive outpatient treatment. In a separate study assessing the effect of managed care on medical and disability costs, Cheadle *et al.* showed no difference in hospitalizations per 1,000 injuries between MC and FFS patients (8.5 vs. 4.3; $p = 0.21$).[81] For outpatient services, however, FFS patients had 22.9 percent more visits than MC patients ($p < 0.01$). The number of OP visits by physician type varied depending on payment status. For example, visits were higher for general practitioners among MC vs. FFS participants (1.9 vs. 0.9; $p < 0.01$) and were higher for chiropractors among FFS vs. MC participants (1.8 vs. 0.3; $p < 0.01$). Regarding chiropractic care, more visits under FFS may reflect lack

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[80] Wickizer TM, Lessler D and Franklin G. Controlling workers' compensation medical care use and costs through utilization management. *Journal of Occupational and Environmental Medicine* 1999;41(8):625-631.
[81] Cheadle A, Wickizer TM, Franklin G, *et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project 2: medical and disability costs. *Medical Care* 1999;37(10):982-993.

of provider availability within managed care programs or characteristics of FFS driven care.

Concurrent review, or review for continued hospitalization beyond the originally approved number of days, was also assessed by Wickizer *et al.*[82] A total of 33.5 percent (N=1,949) of inpatients (IP) seeking additional length of stay (LOS) had concurrent review. Fifty-two percent of these patients had the number of requested hospital days authorized reduced by a mean of 3.6 days. For medical conditions, 6.6 days were requested but only 4.3 days were authorized. For surgical conditions, 3.3 days were requested but only 2 days were authorized.

In 2003, Dembe *et al.* provided a descriptive account of WC inpatient care for all work-related injuries from a 24 state sample.[83] WC patients with inpatient utilization had an average LOS of 4.01 days, a 0.58 day delay from admission to first procedure, and 1.94 procedures per hospitalization. After controlling for various covariates (e.g., age, gender, and geographic region state), WC patients had a longer LOS than other payers, yet time to first procedure was 25 percent shorter for WC patients. Similar findings were seen when assessing upper or lower limb fractures. However, information on the nature, cause, and severity of patient condition was not recorded or included as covariates in this study. In terms of utilization by procedure, disc and spinal disorders (27.9 percent),

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[82] Wickizer TM, Lessler D and Franklin G. Controlling workers' compensation medical care use and costs through utilization management. *Journal of Occupational and Environmental Medicine* 1999;41(8):625-631.
[83] Dembe AE, Mastroberti MA, Fox SE, Bigelow C and Banks SM. Inpatient hospital care for work-related injuries and illnesses. *American Journal of Industrial Medicine* 2003;44(4):331-342.

lower limb fracture (6.4 percent), and device, implant, and other complications (4.0 percent) represent the three most common causes of WC hospitalization. Interestingly, two of the ten most common causes of WC hospitalization involved medical and surgical complications.

In addition to changes in overall utilization patterns, one group of researchers assessed changes in utilization among surgeons after introducing a disability management model at an academic medical center.[84] Before introducing the disability management model, only 32 percent (N=35) of surgical cases were performed by Johns Hopkins University (JHU) Hospital physicians and 68 percent (N=74) were performed by non-affiliated physicians. After introducing the disability management model, which created an in-house WC preferred provider organization (PPO), the number of WC-related surgeries by JHU physicians increased. After introducing the PPO, 91 percent vs. 9 percent of surgical cases were performed by JHU and non-JHU physicians, respectively ($p < 0.001$). Of particular interest to this study is that Maryland is an "employee" choice state; therefore, by law injured workers retained the ability to see any qualified surgeon of their choice for WC care, despite the introduction of the WC PPO. Yet, after the PPO was created, substantially more patients sought care through JHU. The authors concluded that this high rate of JHU physician use "implies acceptance and satisfaction with the care that clients were receiving." Further evidence of this is that from 1993 to 1997, less than 0.05 percent of WC claimants sought care outside of the JHU PPO. However, creation of the

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[84] Bernacki EJ and Guidera JA. The effect of managed care on surgical rates among individuals filing for Workers' Compensation. *Journal of Occupational and Environmental Medicine* 1998;40(7):623-631.

in-house PPO may have led to subtle pressure for injured employees to try the in-network providers, thus possibly skewing participation patterns. In addition, the JHU reputation may have encouraged more injured workers to use the PPO than an out of plan physician.

In a telephone survey of 813 injured Californian WC recipients, Rudolph *et al* assessed patient satisfaction and outcomes after injury.[85] A total of 13.3% of the respondents reported some or a lot of difficulty obtaining medical care. Less than 20 percent saw only one doctor while 25 percent saw 5 or more doctors. In addition, 45 percent of respondents made fewer than 10 visits while 22 percent made 25 or more visits. Respondents reported that allopathic physicians provided 63 percent of care, physical therapists provided 15 percent, chiropractors provided 6.5 percent, and physicians' assistants or nurse practitioners provided two percent.

2.3.4.1. Summary

In general, WC patients had a 25% longer length of stay than patients covered by other payers. However, WC patients had less time to first procedure. Utilization management practices for workers' compensation claimants were successful in reducing utilization in both inpatient and out-patient studies. Utilization management was also successful in reducing LOS associated with continued hospitalization beyond the originally approved treatment protocol. After introducing a disability management model, an academic

[85] Rudolph L, Dervin K, Cheadle A, Maizlish N and Wickizer T. What do injured workers think about their medical care and outcomes after work injury? *Journal of Occupational and Environmental Medicine* 2002;44(5):425-434.

medical center saw a dramatic increase in the number of surgical cases treated by surgeons who participated in this model versus surgeons who did not participate in the model. In comparing FFS vs. MC, there was no statistical difference in hospitalization between the two groups, but the FFS group had a higher number of outpatient visits.

2.3.5. Medical, Indemnity, and Other Cost Outcomes

Eleven studies reported cost outcomes associated with work-related injuries.

2.3.5.1. Overall Cost Outcomes with Managed Care Plans

Overall, WC costs generally decreased after a WC managed care plan was introduced. Results from a disability management model used by Johns Hopkins University Medical Center showed a decrease in total costs from $0.81 in 1992 to $0.37 in 2002 per $100 of payroll.[86] In a separate study conducted at Bank One offices in Michigan, introducing a short-term disability (STD) management program saved approximately $2.25 million in STD benefits.[87]

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[86] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.
[87] Burton WN and Conti DJ. Disability management: corporate medical department management of employee health and productivity. *Journal of Occupational and Environmental Medicine* 2000;42(10):1006-1012.

2.3.5.2. Medical Costs with Managed Care Plans

In the Washington State Managed Care Pilot Program, some clinics were assigned MC status (e.g., with experience-rated capitated payments and an occupational medicine model) and some retained their traditional FFS status. This approach allowed Cheadle *et al*. to assess and compare medical costs for injured workers assigned to a MC or FFS clinic.[88] In order to obtain billable charges in the MC clinic, MC providers submitted shadow bills for all services rendered, despite their capitation reimbursement status. Shadow MC charges were compared to FFS charges in order to determine differences between the two groups. In addition, patients assigned to a MC clinic who used out of network care had only the first non-network care visit deemed "appropriate." As such, only the first non-network care visit was included in MC charges; subsequent visits were deemed "inappropriate" and were not counted towards total charges in the "less conservative" calculations by the authors.

Results showed that the unadjusted mean medical cost of using the less conservative approach was \$587 for MC and \$748 for FFS ($p = 0.06$).[89] However, if all non-network care was assumed appropriate (i.e., the more conservative approach), average MC costs increased from \$587 to \$619, reducing still further the difference between FFS costs ($p = 0.15$). The only significant cost differences in this sample were for general practitioner care, chiropractor care, pharmacy care, and "other" services (all $p < 0.01$). Multivariate

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[88] Cheadle A, Wickizer TM, Franklin G, *et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project 2: medical and disability costs. *Medical Care* 1999;37(10):982-993.
[89] *Ibid.*

statistics were performed, but "patient, injury, and firm factors had little meaningful effect on the estimated cost differences between managed care and FFS." However, evidence showed that outliers may have "influenced the unlogged results." To adjust, the authors removed one MC payment outlier costing \$57,500, which was \$20,000 more than the most expensive FFS injury. When this value was excluded under the more conservative cost assumption, the difference in medical costs for MC and FFS differed by 24 percent, which achieved statistical significance ($p < 0.01$).

In a 1991 study, average ***total*** costs in an HMO were lower than the corresponding FFS plan, but both unadjusted and adjusted analyses based on covariates (e.g., age, gender, job category, injury site, etc.) were not statistically significant (↓34.5%; \$909 vs. \$1,388; $p = 0.06$ and 0.08, respectively). In comparing ***medical*** costs between an HMO and a FFS WC insurer, average medical costs for HMO enrollees were lower than average medical costs for FFS enrollees (↓43.3%; \$475 vs. \$838). This difference was significant for both unadjusted and adjusted analyses ($p < 0.01$).[90]

Four studies reported cost outcomes associated with the introduction of a WC preferred provider organization (PPO) at Johns Hopkins University Medical Center.[91,92,93,94] Three

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[90] Zwerling C, Ryan J and Orav EJ. Workers' compensation cost shifting: an empirical study. *American Journal of Industrial Medicine* 1991;19(3):317-325.
[91] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.
[92] Bernacki EJ and Tsai S. Managed care for workers' compensation: three years of experience in an 'employee choice' state. *Journal of Occupational and Environmental Medicine* 1996;38(11):1091-1097.
[93] McGrail MP, Jr., Tsai SP and Bernacki E. A comprehensive initiative to manage the incidence and cost of occupational injury and illness. Report of an outcomes analysis. *Journal of Occupational and Environmental Medicine* 1995;37(11):1263-1268.

of them reported explicitly on costs before and after introduction of the PPO.[90,91,93] In a 1996 study by Bernacki and Tsai, costs for the first three years of the managed care program (1993-1995) were compared to the last pre-managed care program year (1992).[91] Overall medical costs decreased steadily from $1.75 million in 1993 to $1.51 million in 1995 (a 13.7% reduction). This corresponded with a decrease in medical only claims filed with the WC PPO plan from 155 in 1992 to 96 in 1995 ($p < 0.01$). Per capita medical costs decreased from $81 to $63 from 1992 to 1995. Despite the decrease in medical WC costs, the proportion of these costs as a percentage of total WC costs (e.g., medical plus indemnity plus administrative, etc.) remained steady at between 32.3 and 35.6%.

In a separate study by Bernacki and Tsai in 2003, overall medical, indemnity, and administrative expenses remained stable at about $5 million during the ten-year study period despite the fact that the covered population nearly doubled from 20,969 in 1992 to 39,063 in 2002.[95] Interestingly, during the ten-year study period the PPO model showed significant reductions in per capita medical, temporary total disability, permanent partial disability, and administrative costs. From 1992 to 2002 medical costs were reduced from $81 to $52 per capita (39% reduction); temporary total disability costs were reduced from $53 to $23 per capita (57% reduction); permanent partial disability costs were reduced from $58 to $25 per capita (57% reduction); and administrative costs were reduced from

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[94] Green-McKenzie J, Parkerson J and Bernacki E. Comparison of workers' compensation costs for two cohorts of injured workers before and after the introduction of managed care. *Journal of Occupational and Environmental Medicine* 1998;40(6):568-572.
[95] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.

$49 to $30 per capita (39% reduction). The total per capita amount reduction was 46% over the this ten year period, from $241 to $129 per capita.

In the third study, pre-managed care costs in 1990 were compared to post-managed care costs in 1993 at the Johns Hopkins Hospital, a component of the entire Johns Hopkins Medical Center PPO.[96] Medical costs decreased 51.6% from $372,000 to $179,000. From 1990 to 1993, total WC cost savings for the Johns Hopkins Hospital component of the PPO was $543,200.

Utilization management review also showed cost savings.[97] On average, a denied admission saved $11,401 per case. Eighty-two percent ($803,000) of the total savings was due to denial of spinal surgery (other than fusion). Shifting care from the inpatient to outpatient setting saved approximately $3,060 per case while denial of outpatient treatment saved $3,957 per case. Concurrent review saved approximately $3.22 million, or an average of $1,656 per case. Savings due to preauthorization review were approximately $2.2 million. For spinal surgery (other than fusion) the overall utilization management effect (i.e., for pre-admission review and concurrent review) was $1.61 million and for fusion, $313,400. A major limitation of this descriptive study, however, was a lack of information to determine the clinical appropriateness of access denials and a lack of inferential statistics. Considering this, despite initial savings from a denied

[96] Green-McKenzie J, Parkerson J and Bernacki E. Comparison of workers' compensation costs for two cohorts of injured workers before and after the introduction of managed care. *Journal of Occupational and Environmental Medicine* 1998;40(6):568-572.

[97] Wickizer TM, Lessler D and Franklin G. Controlling workers' compensation medical care use and costs through utilization management. *Journal of Occupational and Environmental Medicine* 1999;41(8):625-631.

procedure, it could be that denied treatment may cost more money over time if the treatment would have been appropriate.

In 1995, Baker and Krueger reported that work-related injuries had an average medical charge of $651 vs. $330 for non-work related injuries.[98] This comparison, which used data from a WC underwriter (for work-injuries) and from Blue Cross / Blue Shield (BCBS) of Minnesota (for non-work injuries) showed that patients covered by WC were charged more per radiographic examination than BCBS patients. However, BCBS patients were charged more for hospitalization. In terms of utilization, regression analysis adjusting for potential covariates of injury type, severity, personal characteristics, and geographic distribution showed that patients with work-related injuries covered by WC insurance received one more examination and slightly fewer radiographs than patients with non-work-related injuries.

In a 2003 study, Dembe *et al.* reported that average hospital charges for WC patients increased by 16 percent from 1997 – 1999 compared to a 9 percent increase for non-WC patients (i.e., private patients).[99] Statistical significance was not reported.

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[98] Baker LC and Krueger AB. Medical costs in workers' compensation insurance. *Journal of Health Economics* 1995;14(5):531-549.
[99] Dembe AE, Mastroberti MA, Fox SE, Bigelow C and Banks SM. Inpatient hospital care for work-related injuries and illnesses. *American Journal of Industrial Medicine* 2003;44(4):331-342.

2.3.5.3. Indemnity Costs Associated with Managed Care

Indemnity costs (i.e., money paid by the insurance company in lieu of salary for lost time from work and injury compensation) are a major portion of total WC costs. The ability to decrease indemnity costs (i.e., income replacement for lost wages) – either by improved treatment or increased RTW, or a combination of both – can have dramatic effects on temporary total disability (TTD) and permanent partial disability (PPD) benefits.

At the Johns Hopkins University Medical Center, TTD costs were reduced after implementing the WC preferred provider organization (PPO). Reporting on the first three years of this program, TTD costs decreased from $53 to $26 per capita.[100] This trend continued after 10 years, reaching $23 per capita in 2002.[101] However, total TTD costs fluctuated during the study period – ranging from a high of $1.11 million in 1992 to a low of $502,000 in 1997. In 2002, total TTD costs increased to $1.012 million, representing both increased accident severity and a doubling of covered population since 1992. Three-year trend data showed that the number of TTD days decreased from 163 to 70 per 100 employees from 1992 to 1995.[102] PPD costs decreased 58 percent from $53 in 1992 to $25 in 2002.[103]

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[100] Bernacki EJ and Tsai S. Managed care for workers' compensation: three years of experience in an 'employee choice' state. *Journal of Occupational and Environmental Medicine* 1996;38(11):1091-1097.
[101] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.
[102] Bernacki EJ and Tsai S. Managed care for workers' compensation: three years of experience in an 'employee choice' state. *Journal of Occupational and Environmental Medicine* 1996;38(11):1091-1097.
[103] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.

2.3.5.4. Component Effect of Pricing and Utilization

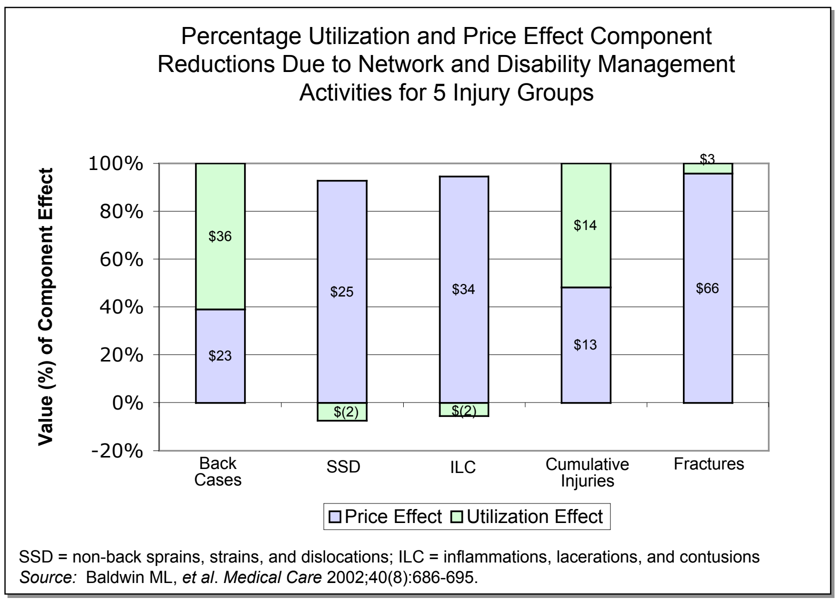
To date, only one post-intervention study discussing the price and utilization component effect has been published.[104] In this study, the authors compared the costs of WC medical care for two groups: (1) groups that received care in the usual fee for service fashion; and (2) groups that received care from a preferred provider organization (PPO). The aims of this study included: identifying overall reductions in cost by using the PPO; identifying the reduction in price (i.e., the difference in payments for medical services attributed directly to network vs. non-network pricing); and identifying reductions in utilization (i.e., the difference in utilization attributed directly to network vs. non-network management). It should be noted that while the primary intervention was PPO implementation, the use of PPOs included additional disease management techniques typically associated with networks.

For claims of less than seven days, Baldwin *et al.* reported overall cost reductions of 11.1% during the three-year study period. Average health care costs were $337 for non-network participants and $299 for network participants (difference of $37.19). Lower utilization accounted for 23.7% ($8.80) of the difference while lower prices accounted for 76.3% ($28.39) of the difference. Of the five injury groups studied, networks appeared to reduce utilization in three injury groups, while having a negative impact in two of them. In addition, the price effect represented a minimum 39% savings for back cases and a

[104] Baldwin ML, Johnson WG and Marcus SC. Effects of provider networks on health care costs for workers with short-term injuries. *Medical Care* 2002;40(8):686-695.

maximum of 100% savings for non-back strains, sprains, and dislocations (SSD) and for inflammations, lacerations, and contusions (ILC). Figure 1 illustrates percentage reductions in costs attributed to the price and utilization component by injury group.

Figure 1: Cost savings by price and utilization component



2.3.5.5. Component Effect for Medical and Indemnity Benefits

Two studies were reviewed. In particular, these studies identified specific savings associated with reduced medical treatment and reduced indemnity benefits after DM activities were implemented. However, unlike the Baldwin *et al* study, these studies did not seek to delineate the component effects as a primary endpoint. Yet, descriptive and inferential information on the component effects are provided and are used as the basis for this section.

2.3.5.5.1. Washington State Program

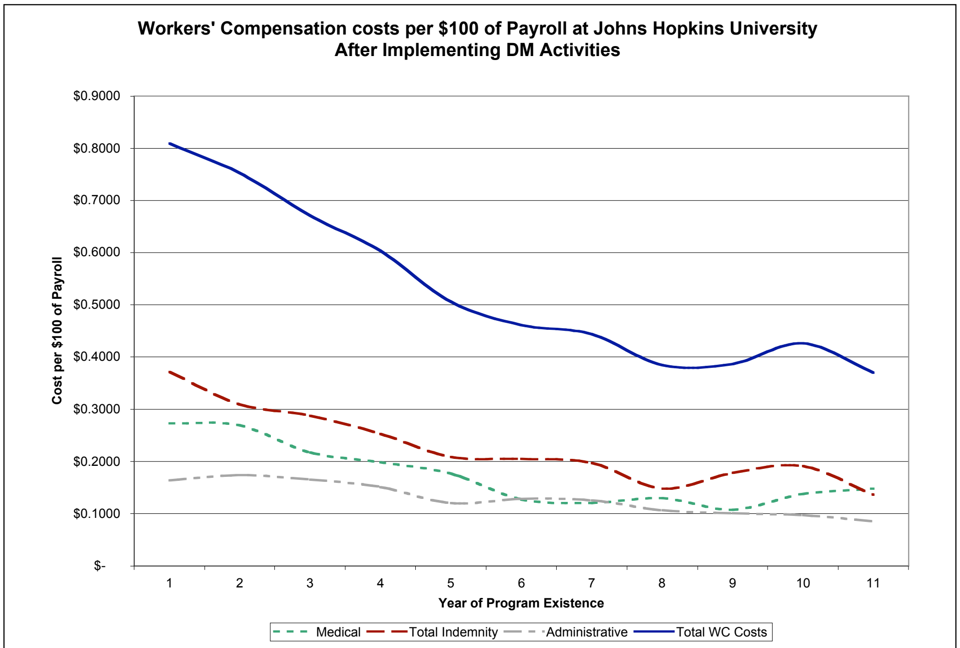
In 1995, Washington State initiated a managed care pilot program to provide WC services. Expenditure and health outcomes from this model were compared with the currently used FFS program. Unadjusted results showed that managed care participants had lower medical costs than FFS participants ($587 vs. $748; difference $161 or 21.5%; $p = 0.06$). It should be noted that while the unadjusted results were not statistically significant at the customary 0.05 level, when additional variables were considered in a regression analysis (e.g., demographics, injury type, seasonality, and matching variables), the difference in medical costs became significant at $p = 0.001$. Unfortunately, monetary values for the adjusted analyses were not provided, therefore unadjusted monetary values will be used for discussion purposes. As for the indemnity component, costs were significantly lower in the MC group ($342 vs. $625; difference $283 or 45.3%; $p = 0.01$). FFS patients had 21.8% more overall visits per injury, including 83.8% more chiropractic visits (1.8 vs. 0.3 mean visits per injury; $p < 0.01$) and 32.4% more visits to "other" providers (0.8 vs. 0.6 mean visits per injury; $p < 0.01$). Interestingly, the number of general practitioner was 109.5% higher in the MC than FFS group (1.9 vs. .9 mean visits per injury; $p < 0.01$), but this is because the definition of general practitioner was expanded to include occupational medicine physicians and other practitioners in the MC group. Total cost reductions in this study favored the MC group by $444, or 32.3% (FFS = $1,373 vs. MC $929; no p-value reported) with medical costs lower by $161 and indemnity benefits lower by $283.

2.3.5.5.2. The Johns Hopkins University Program

A similar approach to treating WC injuries was introduced by the Johns Hopkins University in 1992. In this setting, a comprehensive preferred provider organization (PPO) with an emphasis on DM activities was implemented to care for injured JHU workers. Interesting facets of this program were the introduction of an occupational medicine approach, worksite and job intervention, early RTW, and guideline use. Ten-year follow-up data indicates that the PPO and DM approaches reduced costs and improved outcomes for WC claimants.

A key finding of the JHU program is that while overall WC costs remained stable during the 10-year study period, the number of workers covered by the program nearly doubled. Indeed, *per capita payroll costs* for WC claims dropped dramatically during the 10-year study period. Overall WC costs decreased 54.2% from \$0.81 to \$0.37 per \$100 of payroll while medical costs decreased 45.8% from \$0.27 to \$0.15 per \$100 of payroll, indemnity benefits decreased 63.3% from \$0.37 to \$0.14 per \$100 of payroll, and administrative costs decreased 47.8% from \$0.16 to \$0.09 per \$100 of payroll. Figure 2 shows changes in WC care costs during the 10-year study period.

Figure 2: Costs associated with providing workers compensation at a major medical center after implementing disease management activities from 1992 to 2002



Source: Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2000;42(10):1006-1012.

2.3.5.6. Early Workplace Intervention Study

In 2003, Arnetz *et al*. reported results from an early workplace intervention study. The intervention included a more proactive role for insurance case managers and an increase in workplace ergonomics assessments. The results of this study suggest that implementing DM activities like physical therapy, early diagnosis, care management, ergonomic assessment, job accommodation, and early RTW can decrease absenteeism.

Study results were calculated to include cost reductions only and cost reductions plus program costs. Results of cost reductions only showed lower costs per case in the intervention group as measured by total reimbursement from the Swedish National

Health Insurance Plan as compared to the control group ($9,592 vs. $12,197; difference $2,605; -21.6%; $p < 0.01$). When intervention costs were included ($1,410) the average per case cost for the intervention group increased to $11,002 for a cost reduction of 9.8% (p value not reported). It is not clear whether program costs were initial one-time costs or on-going costs.

2.3.5.7. Summary

The effect on medical costs due to WC managed care showed inconsistent results across studies. One study showed lower costs for WC vs. FFS when an expensive WC outlier was removed. A second study found no difference in costs between MC and FFS plans. Utilization management showed an ability to reduce costs – saving $3,060 per case when cases were switched to outpatient care from inpatient care and saving $3,957 when outpatient care was denied. Concurrent review saved, on average, $1,656 per case.

In terms of overall medical costs, the introduction of a WC preferred provider organization in an academic medical center decreased overall and per capita medical costs. A ten-year follow-up showed absolute medical expenses decreased by nearly half ($0.27 vs. $0.15) per $100 of payroll and that per capita medical costs decreased 39 percent from $81 in 1992 to $52 in 2002. Because the JHU PPO operated in an academic medical center, these results may not be generalizable in a community setting. Nevertheless, these studies offer a glimpse of the type of disability management service that can be provided to injured WC patients and the extent to which savings might occur.

Only one study assessed the effect that WC managed care has on indemnity costs. In this study, a WC preferred provider organization was established. In the first three years of the PPO, indemnity claims decreased from $53 to $26 per capita, further decreasing to $25 per capita in 2002, a total decrease of 53 percent.

One study assessed the component effect of price and utilization, showing a much greater impact on price after networks were created than on utilization. However, over time, it is likely that the utilization component will exert a strong pull. Two studies assessed the component effect for medical and indemnity benefits. Results from the Washington State model showed reductions in lost time costs and medical costs of 45.3% and 21.5%, respectively. The Johns Hopkins study showed greater cost reductions of 63.3% and 45.8% for indemnity costs and medical costs, respectively. The greater cost reductions in the Johns Hopkins Study is presumably because it has access to specialized medical care via Johns Hopkins Hospital and long-term effort to improve WC care and promote RTW.

2.3.6. Return-to-Work Characteristics

A key priority in disability management is to encourage workers to return to work. As such, assessing RTW characteristics has played an integral part in evaluating disability management models. Eight studies reviewed RTW characteristics.

At the Johns Hopkins University Medical Center, an integrated, facilitated early return to work program was initiated.[105] This program included case management, job analysis, alternate work assignment development, job hazard elimination, and employee education about the program. Workers were encouraged to return to work by stressing rehabilitation and job accommodation, as appropriate. The results compared pre- and post-program implementation (1989-1992 vs. 1993-1999). The number of lost workday cases per 1,000 employees decreased from 19.8 to 10.0 ($p \leq 0.0036$) after the early return to work program was initiated.

In a study by McGrail *et al*., evaluating the same JHU disability management model using a different time period of analysis (1992 vs. 1993), there were significant decreases in worker morbidity.[106] For example, comparisons prior to and after introducing the disability management model showed a 23 percent decline in the morbidity incidence ratio. This decrease was largely due to decreased work-related injuries among hospital workers. Indeed, 78.4 percent (N=385) of injuries in 1992 resulted in lost workdays while only 55.2 percent (N=217) of injuries in 1993 resulted in lost workdays ($p < 0.01$). Due to the study design, however, it is not possible to attribute the entire decrease to the introduction of managed care alone. Other factors at work at the time included switching to a needleless intravenous administration system along with a renewed emphasis on preventing strains and contusions at the JHU Hospital.

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[105] Bernacki EJ, Guidera JA, Schaefer JA and Tsai S. A facilitated early return to work program at a large urban medical center. *Journal of Occupational and Environmental Medicine* 2000;42(12):1172-1177.
[106] McGrail MP, Jr., Tsai SP and Bernacki E. A comprehensive initiative to manage the incidence and cost of occupational injury and illness. Report of an outcomes analysis. *Journal of Occupational and Environmental Medicine* 1995;37(11):1263-1268.

In addition, the number of employees participating in restricted work duty days increased after JHU implemented its disability management program. In 1992, only 5.5 percent (N=27) of all injured workers participated in restricted work duty days, increasing to 15 percent (N=393) of all injured workers in 1993 ($p < 0.01$). In terms of days, the average number of restricted work duty days increased from 0.2 days in 1992 to 1.5 days in 1993 ($p < 0.01$). This increase represented a "liberal" policy of returning injured workers as soon as possible to their jobs, even if this required accommodation. It also represented a key component of the disability management model, namely recognizing the needs of an injured worker while allowing him to continue working and accommodating his injury as appropriate.

In a study of 608 workers in Northeast Cincinnati, RTW outcomes in a WC care management model were compared to established RTW benchmarks.[107] Features of this care management model included: (1) methods to reduce administrative delays and an emphasis on timely and accurate communication; (2) use of a sports medicine approach to achieving early diagnosis in order to enable aggressive treatment; and (3) a focus on RTW management featuring direct communication with employee supervisors to determine RTW options. Unique to this study is a comparison of lost work days in the intervention group (i.e., the care management model group) versus a usual care benchmark and an optimal care benchmark.

[107] Linz DH, Ford LF, Nightingale MJ, *et al.* Care management of work injuries: results of a 1-year pilot outcome assurance program. *Journal of Occupational and Environmental Medicine* 2001;43(11):959-968.

Results of this study showed that 418 patients had both an available ICD-9 code and RTW data.[108] The mean number of days to RTW was 6.99 ± 7.64 days, with a total of 2,137 days off work. This number was substantially less than usual care and optimal care RTW benchmarks. For example, care management patients had a total of 3,702 fewer days off work than usual care patients (mean 8.9 fewer days) and 785 fewer days off work than optimal care patients (mean 1.9 fewer days). For both comparisons, care management days off work were significantly less ($p \leq 0.05$). Financially, when valued at $200 per day, the value of the "saved" lost workdays was $740,000 and $157,000 versus usual care and optimal care, respectively.

Dasinger *et al*. reported patient outcome results for patients based on the "proactivity" of the physician.[109] Proactivity is defined as "the degree to which the treating physician gathers and/or imparts information about the workers' job, preventing reinjury at the job, and returning to modified work."[110] Patients cared for by proactive physicians or by physicians who at any given time said the worker was ready to RTW were 20-39 percent more likely to RTW than workers treated by non-proactive physicians. For acute care physicians (i.e., physicians who treated a patient for the first 30 days of the patient's injury), the results were only "marginally significant" (RR: 1.39; $p = 0.05$ for proactivity and $p = 0.06$ for mentioning RTW). Once age was included as a covariate, statistical significance was reduced to $p = 0.07$. However, for chronic care physicians (i.e.,

[108] *Ibid.*
[109] Dasinger LK, Krause N, Thompson PJ, Brand RJ and Rudolph L. Doctor proactive communication, return-to-work recommendation, and duration of disability after a workers' compensation low back injury. *Journal of Occupational and Environmental Medicine* 2001;43(6):515-525.
[110] *Ibid.*

physicians who treated a patient for days 31 – 90 of the patient's injury), saying a patient was ready to return to work was associated with increased RTW rates for most models observed (e.g., models that included age, sex, injury factors, and psychosocial workload) (all $p \leq 0.02$).

In a study of US civilian federal workers by Feuerstein *et al.*, RTW outcomes on 131 injured workers were assessed.[111] Forty-five percent (N=59) of workers had RTW data. Regression analysis showed that older age, upper extremity functional limitations, and lower levels of patient satisfaction at post-intervention assessment "significantly predicted longer duration to RTW, accounting for 28 percent of the variance" (all $p < 0.05$).[112]

A study of blue-collar production line workers from a Michigan-based car manufacturer revealed that those who were younger (40.2 vs. 47.3 years; $p < 0.01$), had more education (completion of grade 12 vs. grade 10; $p < 0.04$), had higher pre-injury wages ($453 vs. $367; $p < 0.05$), and had more seniority (15.5 vs. 12.0 years; $p < 0.05$) were more likely to RTW sooner than those in the comparison categories.[113] In this study of 200 workers, four cohorts of 50 were analyzed: (1) a vocational rehabilitation and returned to work cohort (VR/RTW); (2) a vocational rehabilitation and did not return to work cohort

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[111] Feuerstein M, Huang GD, Ortiz JM, *et al.* Integrated case management for work-related upper-extremity disorders: impact of patient satisfaction on health and work status. *Journal of Occupational and Environmental Medicine* 2003;45(8):803-812.
[112] *Ibid.*
[113] Tate DG. Workers' disability and return to work. *American Journal of Physical Medicine and Rehabilitation* 1992;71(2):92-96.

(VR/no-RTW); (3) a no vocational rehabilitation and returned to work cohort (no-VR/RTW); and (4) a no vocational rehabilitation and no return to work cohort (no-VR/no-RTW). Select results reveal that VR/RTW had more arm and shoulder injuries ($p < 0.01$) and had a higher incidence of knee and leg injury than the other groups ($p < 0.02$). VR/no-RTW workers had a higher incidence of surgery than other groups ($p < 0.01$).

In 1994, a study of 28,473 claims from the Washington State Department of Labor and Industries examined factors related to duration of work-related disability.[114] Survival analysis indicated most disability is short term, over half of injured workers will RTW by one month, and that only 20 percent remain disabled and off work at six months. Only 12.5 percent of claimants remained off work at one year while 7.4 percent remained off work for two years. Some factors influencing time off (with an increase in duration of disability) included: carpal tunnel syndrome (45 percent), age > 45 (33 percent), back / neck sprain (21 percent), female gender (15 percent), other sprain (13 percent), having dependents (12 percent), and fracture (12 percent). Workers in counties with high unemployment showed an increasing trend towards increased days off work as the unemployment rate rises.

[114] Cheadle A, Franklin G, Wolfhagen C*, et al.* Factors influencing the duration of work-related disability: a population-based study of Washington State workers' compensation. *American Journal of Public Health* 1994;84(2):190-196.

RTW was also assessed by Rudolph *et al.* in their WC patient satisfaction study.[115] Ninety-four percent of respondents noted that they worked during their injury and 44 percent of workers said they returned to work too soon. Thirty-eight percent of workers had accommodations, changes in job assignment, or job restrictions and of these, 79 percent were happy with the change.

2.3.6.1. Summary

Several studies implemented facilitated early return to work programs. In general, studies that implemented an early return to work program (e.g., case management, job analysis, alternate work assignment) had less time loss per 1,000 than those without an early return to work program. At Johns Hopkins University, the number of lost workdays decreased from 19.8 to 10.0 after the program was initiated. This program also led to an increase in the number of restricted work days (i.e., led to increased return to work participation by employees on restricted or modified duty). A second study reported fewer days off in a care management model as compared to both optimal RTW benchmarks and standard RTW care.

Three studies examined factors related to duration of work-related disability. Older age, upper extremity functional limitations, low levels of patient satisfaction, lower pre-injury wages, less education, and who less seniority at work were factors more likely to stay

[115] Rudolph L, Dervin K, Cheadle A, Maizlish N and Wickizer T. What do injured workers think about their medical care and outcomes after work injury? *Journal of Occupational and Environmental Medicine* 2002;44(5):425-434.

increase lost time following an injury. In terms of amount of time off work, a study in Washington State showed that only 20 percent of people remained off work longer than 60 days.

2.3.7. Time Loss Characteristics

Five studies reviewed time loss characteristics among injured WC patients.

In 1999, Cheadle *et al*. reported that both the percentage of workers on time loss and the amount of time loss payments were lower in a MC group vs. a FFS group.[116] In the MC group, 14.7 percent of workers were on time loss during a one-year period vs. 19.2 percent for the FFS group ($p < 0.01$). Time loss payments were also lower in the MC group ($342 vs. $625; $p < 0.01$). Similarly, in a 1995 study reporting changes in lost time after introduction of MC, McGrail *et al*. reported a 33 percent reduction in lost time days per episode from 10.4 to 6.6 days when comparing pre- and post-managed care intervention ($p < 0.01$).[117] However, some of this reduction could have been due to ongoing initiatives seeking to decrease hospital-based strains, sprains, and needle stick injuries.

Another study reviewed the likelihood that an occupationally-based early intervention program would have an effect on injury claim incidence, duration of injury, and cost of injury.[118] In this study from Saskatchewan, results from three comparison groups were analyzed. Group 1 compared standard care in company A vs. an early intervention

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[116] Cheadle A, Wickizer TM, Franklin G, *et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project 2: medical and disability costs. *Medical Care* 1999;37(10):982-993.

[117] McGrail MP, Jr., Tsai SP and Bernacki E. A comprehensive initiative to manage the incidence and cost of occupational injury and illness. Report of an outcomes analysis. *Journal of Occupational and Environmental Medicine* 1995;37(11):1263-1268.

[118] Lemstra M and Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in workers' compensation claims. *Spine* 2003;28(3):299-304.

program (EIP) in company B; group 2 compared an occupationally managed protocol (OMP) vs. standard care in company A; and group 3 compared OMP in company A vs. an EIP in company B. Results indicated that of the three different interventions (i.e., standard care, OMP, and EIP), EIP was the most costly and time consuming. In fact, because of the aggressive nature associated with EIP (i.e., early intervention) "it is presumed that aggressive referral to expanded physical therapy might have resulted in the treatment of many workers [who] would have recovered more quickly without the enhanced intervention. As such, many workers had [to delay RTW] plans [in order] to complete their 6- to 10- week work hardening and conditioning programs"[119] before actually returning to work. Of the three models, OMP seems to have the best results – reduced claim incidence, reduced days off, and reduced cost of claims processing.

In 2004, a study by Lemstra and Olszynski reported the impact of occupational management on treating WC injuries as compared to using early intervention (EI) in one small company in Canada. EI was defined as "immediate and intensive physical therapy and work hardening" rather than prevention activities.[120] In two comparisons, the authors focused on: (1) occupational management as the control group vs. EI as the intervention; and (2) EI as the control group and EI combined with occupational management as the intervention. In the first comparison, medical and indemnity compensation for work-related upper extremity musculoskeletal disorders (WRUEM) and back injuries were

[119] *Ibid.*

[120] Lemstra M and Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in Workers' Compensation claims: part 2. *Spine* 2004;29(14):1573-1579.

$6,028 per 100,000 hours worked in 2000 compared to $16,360 per 100,000 hours worked 2001 for the EI intervention group (171.4% increase). Conversely, facilities that switched from EI to an EI / occupational management hybrid reduced total medical and indemnity costs per 100,000 hours from $132,097 in 2001 to $77,571 in 2002 (41.3% decrease). P-values for these comparisons were not reported.

A study by Kenny using administrative claims data from the New South Wales, Australia Workers' Compensation Bureau (i.e., the Work Cover Authority) identified variables accounting for time loss among injured workers.[121] In this retrospective study, Kenny hypothesized that injury variables would exert the greatest impact on explaining time loss. Three sets of variables were used in three different regression models. Model 1 used injury variables (e.g., mechanism of injury, agency of accident, nature of injury, bodily location of injury, results of injury) in the regression analysis. These variables accounted for 28 percent of the variance ($p < 0.001$). Model 2 examined worker variables (e.g., gender, age, marital status, number of dependent children, award rate of pay, employment status, costs of injury, and use of rehabilitation) while holding injury variables from model one constant. Model 2 variables accounted for an additional 34 percent of the variance ($p < 0.001$). The third model used three variable types (i.e., industry type, insurer type, and employer size) and "was the least robust of the three models."[122]

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[121] Kenny D. Determinants of time lost from workplace injuries: the impact of the injury, the injured, the industry, the intervention and the insurer. *International Journal of Rehabilitation Research* 1994;17(4):333-342.
[122] *Ibid.*

2.3.7.1. *Summary*

Injured workers treated under a WC managed care plan had less percentage time loss than corresponding FFS workers. A similar trend was seen in a second study that showed an occupationally managed protocol resulted in reduced days off due to injury when compared to standard care or early intervention care. A third study compared the effect of three sets of variables to determine which had the biggest impact on time loss. Of variables used to assess injury, demographics, and industry/employer type, demographic variables (e.g., gender, age, marital status, etc.) accounted for 34 percent of the time loss variance. Twenty eight percent of the variance was accounted for by injury variables.

2.3.8. Geographic Characteristics

Two studies specifically reported on geographic variations of expenditure associated with workers' compensation. One study reported on geographic variations in WC hospital compensation claims[123] while the other reported on geographic variations in WC physician compensation claims.[124] Both studies were reported by the same authors and used the same data set and data methodology. Briefly, 35,231 claims from the Detailed Claims Database administered by the National Council on Compensation Insurance from 1979 – 1988 were analyzed. Analyses included all medical and ancillary payments per

[123] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation hospitalized claims. *American Journal of Industrial Medicine* 1999;35(2):103-111.
[124] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation physician claims *American Journal of Industrial Medicine* 1997;32(1):27-34.

episode for 17 participating states. Inpatient physician charges and hospital charges were combined and the payment variable was converted to the natural logarithm because payment distribution began at $0 and had a long upper tail. Louisiana generally had the highest payments in the sample, and thus was used as the comparison state. For both studies, the null hypothesis was that no difference existed between states with regard to compensation amounts (e.g., for hospital claims or for physician claims).

In the 1999 study assessing geographic variation of WC hospital compensation claims, Miller and Levy rejected the null hypothesis (i.e., they determined there were interstate differences in compensation claims).[112] The magnitude of cost variations differed across states. Several northeastern states (e.g., Connecticut, Massachusetts, and New York) and Minnesota had lower costs – ranging from 30 – 50 percent lower – than Louisiana for lower and upper extremity fractures (all $p < 0.05$). For back injuries, costs were lower for New York, Connecticut, and Wisconsin (range: 15 – 25 percent; $p < 0.05$) than for Louisiana. Michigan and Pennsylvania have back injury costs that are about 10 percent higher than Louisiana, but this difference was not significant ($p < 0.10$).

In terms of cost-control measures, states with mandatory hospital rate setting (e.g., Connecticut, Massachusetts, and New York) generally had lower costs. For example, states with mandatory rate settings had costs that were 26 percent less for arm and leg fractures ($p < 0.001$), 45 percent less for non-fracture / non-rupture upper extremity injuries ($p < 0.001$), and 41 percent less for back sprains and strains ($p < 0.001$). States with hospital fee schedules had 5 percent lower costs for arm and leg fractures (p <

0.001) and 3 percent lower costs for upper extremity injuries, although this difference was not significant ($p = 0.15$).

In the 1997 study assessing geographic variation of WC physician claims, Miller and Levy also rejected the null hypothesis (i.e., interstate variations in occurred physician payments for WC claims).[125] For example, costs for upper and lower extremity fractures were from 10 – 20 percent lower in Florida, Georgia, New York, Pennsylvania, and Virginia than Louisiana and from 30 – 40 percent lower for Kentucky and Massachusetts than Louisiana (all $p < 0.05$). However, differences in costs associated with the three types of injuries studied (i.e., arm and leg fracture, other upper injuries, and back strain or sprain) only accounted for 10 percent of cost variations.

To further delineate interstate cost variations, the authors controlled for "characteristics of the injuries, the injured, and the state health care environment."[126] When controlling for personal (e.g., age, gender, etc.) and injury variables "these equations explain [considerably] more variation in cost" and significant interstate variation in costs remains (as demonstrated by the F statistic for all state effects; $p < 0.05$).[127] Personal characteristics and injury variables are significant ($p < 0.001$). After including state characteristics, significant interstate variation remains ($p < 0.05$ for the joint F-statistic for all state effects). However, after including state characteristics, the following factors

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[125] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation physician claims *American Journal of Industrial Medicine* 1997;32(1):27-34.
[126] *Ibid.*
[127] *Ibid.*

change costs: the percentage of population living in urban areas decreases costs for "other" injuries and back sprain / strain ($p < 0.05$); availability of a regional trauma center decreases costs for all categories except back strains / sprains ($p < 0.05$); and percentage of populations in HMOs decreases costs for upper and lower extremities ($p < 0.01$) and increases costs for back sprain / strain ($p < 0.01$).

2.3.8.1. Summary

Together, results of both of these studies indicate that interstate variations occur in WC claims for both hospital and physician charges. Limitations for both studies include sampling restriction to the three types of injuries studied and interstate variation may not reflect intrastate variation.

2.4. Literature Review Summary and Future Direction

This review critically examined issues related to providing care for injured workers covered under the workers' compensation system. In particular, it focused on different models of WC care delivery – ranging from traditional FFS plans to novel managed care initiatives. Studies discussing disability management models were emphasized in order to highlight the continued evolution of managed care from a strict cost-control viewpoint to a more comprehensive cost-effectiveness perspective. This literature review was based on empiric studies in order to provide the most current, evidence-based data available to all stakeholders involved. In all, eight domains were reviewed.

Results from these studies suggest that managed care, and in particular, disability management, can provide improved health outcomes, improved RTW status, and reduced costs when compared to traditional FFS workers' compensation models. The end result, however, is that costs should not be the sole driver of WC care. Rather, cost should be just one of several components used in managing injured workers, healing their injury, and returning them to work. Additional components to a successful WC care model include:

- Worker and employer satisfaction benchmarks
- Quality of care benchmarks
- Injury assessment
- Workplace assessment
- Ergonomic assessment
- Appropriate rehabilitation and accommodation
- Case management activities
- Appropriate provider networks (e.g., physicians and nurses trained in occupational medicine / industrial hygiene)

Ideally, incorporating some or all of these components will increase the overall effectiveness of WC care by forging a partnership with the worker, employer, and physician. Such a partnership will encourage both individual and collective responsibility by all parties toward the primary objective – provision of prompt and appropriate medical and rehabilitative care that allows an injured worker to return to his or her job in a timely fashion.

The literature review also discussed current trends for medical service utilization, medical expenditure, and lost time from work, all of which are dependent variables in the current study. In the case of medical service utilization, the literature showed that when FFS was compared to MC, the number of inpatient visits for both groups are similar, but FFS patients have more outpatient visits. Utilization management, however, has been shown to significantly reduce inpatient and outpatient admissions. In the current study of the Texas WC FFS system, differences in medical service utilization based on specific patient, physician, and non-clinical independent variables (e.g., age, gender, race, physician specialty, etc.) will be assessed while taking certain covariates into account.

Medical service expenditure is also a key variable of interest in the current study and was discussed in the literature review. Workers' compensation medical and indemnity costs generally decreased after the introduction of WC managed care plans because of increased utilization management (i.e., more appropriate medical services) and rehabilitation services. This current study will assess the current state of medical expenditure in the Texas WC system based on specific medical diagnoses, patient demographics, and physician characteristics.

Lost time from work, another key area of interest for the current project, was analyzed in the literature review. Specifically, the literature review assessed disability management and rehabilitation models. A commonality among these models is that workers who had appropriate rehabilitation, accommodation, and support were likely to return to work sooner. In addition, characteristics of those returning to work (e.g., more education, higher wages, etc.) were also identified and quantified. In the current study, key patient characteristics identified in the literature review, along with other potential factors of interest, will be analyzed to identify drivers of lost time from work.

2.5. Model of Health Care Service Utilization

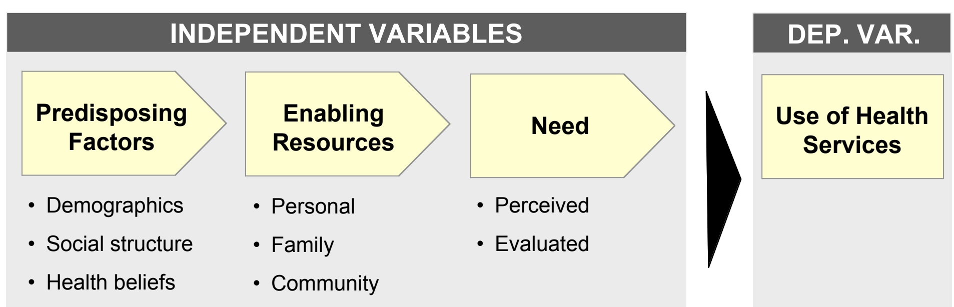
Health care service utilization is a complex activity involving interplay between individual characteristics, environmental influences, and societal pressures.[128] In the previous section, 34 studies were assessed showing how the health outcomes of WC claimants were affected after specific interventions were introduced. Yet these studies did not identify underlying constructs or conceptual models associated with health care service utilization among WC claimants. A further search of the literature did not yield any additional studies discussing such a relationship. However, despite a lack published literature on this subject, a conceptual model of health care service utilization may provide insight into the behaviors of injured workers seeking medical care for their injury.

In the late 1960s, Andersen and colleagues developed what became known as the Andersen Model of Health Care Service Utilization. The original intent of this model

[128] Andersen RM and Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Memorial Fund Quarterly*:95-124.

was to both *predict* and *explain* health care service utilization.[129] The initial behavioral model proposed a conceptual framework of predisposing characteristics, enabling resources, patient and physician need, and use of health care services. "Use of health care services" is the dependent construct and is influenced by the explanatory constructs of predisposing characteristics, enabling resources, and need. Predisposing characteristics include demographic factors (e.g., age and gender), social structure (e.g., socio-economic status), and health beliefs (e.g., attitudes, values, and knowledge about health care). Enabling resources include the facilities and people needed to provide health care services. Finally, the need for health services – both perceived need by the patient and evaluated need by the health care provider – plays a role in the quantity and type of health service provided. Figure 3 shows the initial behavioral model of the 1960s.

Figure 3: The initial 1960s model of health care service utilization[130]



In the 1970s, researchers at the Center for Health Administration Studies at the University of Chicago expanded the initial behavioral model. In the expanded model, the

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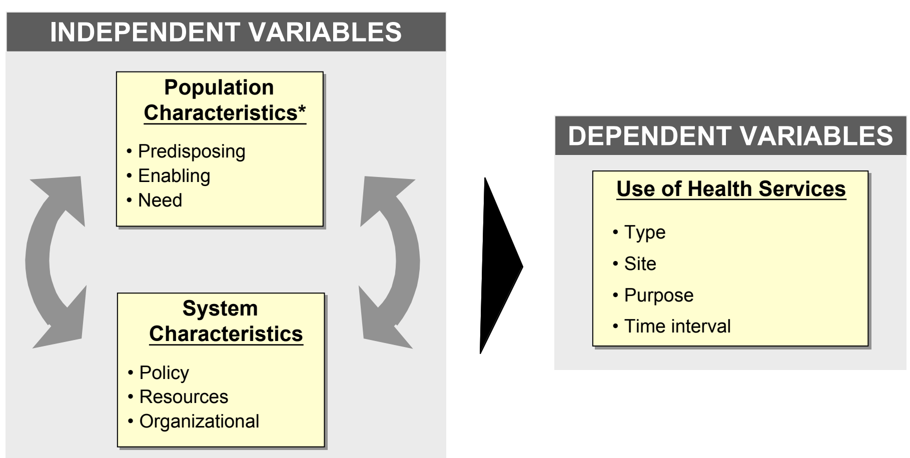
[129] Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *Journal of Health and Social Behavior* 1995;36(3):1-10.
[130] *Ibid.*

health care system was "explicitly included" in order to highlight the importance of health policy, resources, and health system organization as determinants in individual health care utilization.[131] Other advancements by the University of Chicago team under the leadership of Lu Ann Aday, led to an expansion of the dependent construct "Use of Health Services." Additional outcome variables included in this construct are the type, site, purpose, and time interval associated with using health services. Another outcome measure called consumer satisfaction was also added to the revised model; however because consumer satisfaction occurs after health services have been used, it is not considered further. Figure 4 shows the revised 1970s model of health care service utilization.

Figure 4: The revised 1970s model of health care service utilization[132]



* The population characteristics in this model were previously described as the independent variables in the original 1960s behavior model.

[131] *Ibid.*
[132] *Ibid.*

As noted above, a review of the literature did not yield any publications discussing the use of the Andersen Health Care Services Utilization Model among workers' compensation claimants. One possible explanation for the lack of such publications is the unique structure of workers' compensation, namely that it is a mandated employee benefit. That is, because WC coverage is available to all workers who suffer an occupational injury (within the confines of rules and regulations regarding WC coverage in a particular state) some of the underlying characteristics and factors used to explain health service utilization may not explain utilization among the WC population. Table 1 describes key variables of the Andersen model and their applicability in explaining health service utilization among WC claimants.

Table 1: Key characteristics from the revised Andersen Health Services Utilization Model and the applicability of these characteristics in explaining health service utilization among WC claimants

Model Characteristic	Applicable	Explanation
Demographic factors	Yes	Factors such as age and gender may explain health service utilization among WC claimants.
Social structure or socio-economic status	Not applicable	The retrospective database design used in this study does not capture the appropriate variables to determine social structure.
Health beliefs	Not applicable	The retrospective database design used in this study does not capture claimant attitudes, values, and knowledge about health beliefs.
Location of provider	Not applicable	The retrospective database design used in this study does not capture distance from a claimant's home or place of work and the healthcare provider.
Income of injured worker	Possibly	Income is an enabling factor that may explain healthcare service use. In the case of WC, income per se should not be a factor in health service utilization. This is because workers' compensation (WC) coverage is based on the fact that an injury occurred at work. Medical services for the injured worker is provided free at the point of care. However, even in cases where medical care is provided free at the point of contact (e.g., the British National Health Service), income may act as a proxy for ability to seek out medical care.
Health insurance benefits	Not applicable	All claimants in this study are covered by WC insurance which makes care at the point of contact free for the claimant.
Regular source of care	Not applicable	The retrospective database design used in this study does not provide information on whether the claimant has a regular source of care.
Travel and waiting times	Not applicable	The retrospective database design used in this study does not provide information on travel and waiting times.
Perceived need	Yes	Perceived need for treatment can be assumed to have occurred based on the fact that a claim was filed.
Evaluated need	Yes	Evaluated need for treatment can be assumed to have occurred based on the fact that a claim for treatment has been submitted by providers.
State health policy	No	The retrospective database design used in this study does not provide information on specific policies or state regulations, even though overall WC policies are based on state regulations. Also, any existing state regulations should be applied consistently to all WC claimants.
Resource availability	No	The retrospective database design used in this study does not provide information on resource availability by a specific provider.
Type of care	Yes	Data are available on procedural codes, physician type, and specialist designation.

Model Characteristic	Applicable	Explanation
Site of care	Yes	Data are available on the site of care (e.g., emergency room visit, surgery, office visit) and the specific site of body part injured.
Purpose of visit	Yes	ICD-9 diagnosis codes act as a proxy for visit purpose.
Time interval	No	The retrospective database design used in this study does not provide information regarding the time interval between initial injury and subsequent care.

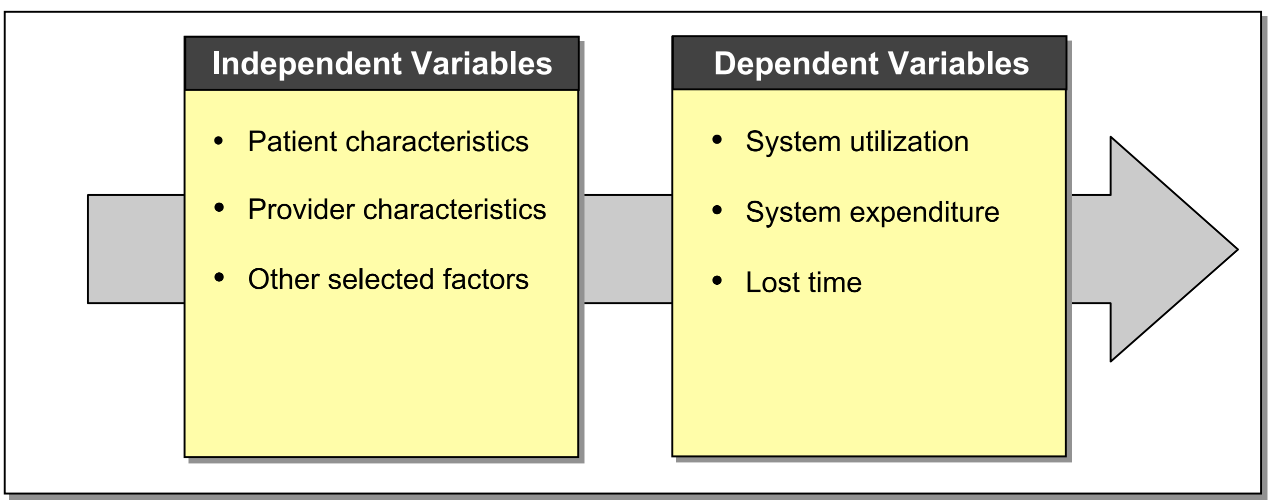
The Andersen Model will serve as a general framework for this study. The complete model cannot be applied to this project because of a lack of data and because of limitations imposed by the study population (i.e., workers' compensation claimants do not exhibit the same characteristics as the everyday population for some of the key explanatory variables identified by the Andersen Model). The Andersen Model however, will be used to guide the assessment of the relationships represented in the data.

3. Study Rationale and Objectives

3.1. Rationale and Objectives

Workers' compensation is a major expenditure for companies, not only in Texas, but also throughout the nation. Yet, with rising costs of WC coverage, many employers see the cost of providing WC coverage more as a burden than a simple act of doing business. As such, methods to control WC costs – both in terms of health expenditure and indemnity benefits – are important to ensure that employers in the state of Texas continue to participate and support WC regulations, provide coverage, and ensure workers receive appropriate benefits. It is also extremely important that cost-control methods do not diminish health outcomes. The purpose of this study, therefore, is to identify relationships between system utilization and expenditure and patient characteristics, provider characteristics, and other selected factors (see Figure 5).

Figure 5: Independent and dependent variables used in this study



3.1.1. Specific Study Objectives

3.1.1.1. Objective 1

Identify and review the current literature on lost time, disability management, and system expenditures related to workers' compensation injury and disability

Conduct a comprehensive literature review to identify relevant empiric studies on current trends in WC care related to lost time, disability management, and system expenditure. The information from these studies will be used to estimate changes in system cost and utilization patterns (see Objective 7).

3.1.1.2. Objective 2

Identify and review time loss and disability management programs in other settings and determine their relevance and feasibility for use in Texas

Conduct a comprehensive review of time loss and disability management programs in other settings to determine the merit of these programs and if components of these programs might be feasible for use in the Texas workers' compensation system.

3.1.1.3. Objective 3

Profile Texas Workers' Compensation claimants and providers from January 1, 2001 to December 31, 2001

Profile Texas workers' compensation claimants for the following:

- Independent variables: age, gender, race, ethnicity, wage, location of claim, length of claim, injury source, and nature of injury
- Dependent variables: lost time, service utilization, expenditures

Profile Texas workers' compensation providers for the following:

- Independent variables: provider type (medical doctor, chiropractor, etc.), provider specialty, number of WC patients treated, and injury type
- Dependent variables: service utilization and expenditures

3.1.1.4. Objective 4

Identify relationships between (A) patient characteristics; (B) physician characteristics; and (C) other selected factors and medical service utilization, expenditure, and work loss

Statistical analyses will be used to determine if patient and physician characteristics as well as other selected factors are associated with medical service utilization, expenditure, and work loss.

3.1.1.5. Objective 5

Identify (A) patient characteristics; (B) physician characteristics; and (C) other selected factors associated with high medical service utilization, expenditure, and work loss in the Texas Workers' Compensation System.

Results from Objective 4 are used to identify patient and physician characteristics as well as other selected factors associated with high medical service utilization, expenditure, and work loss among Texas workers' compensation claimants in order to explain relationships between these factors.

3.1.1.6. Objective 6

Develop a model to predict medical service utilization, expenditure, and work loss based on patient characteristics, physician characteristics, and other selected factors

Results obtained from Objectives 4 and 5 are used to develop a model that can predict future utilization, expenditure, and work loss patterns among Texas workers' compensation claimants.

3.1.1.7. Objective 7

Estimate changes in system cost and utilization patterns after implementing evidence-based disability management programs based on the literature

Estimation from the literature will be applied to the current data set to estimate the effects of evidence-based disability management programs on future utilization, expenditure, and work loss patterns among Texas workers' compensation claimants.

3.1.2. Hypotheses

3.1.2.1. Objective 1

This objective does not have specific hypotheses associated with it.

3.1.2.2. Objective 2

This objective does not have specific hypotheses associated with it.

3.1.2.3. Objective 3

This objective does not have specific hypotheses associated with it.

3.1.2.4. Objective 4

3.1.2.4.1. PATIENT CHARACTERISTICS

All patient characteristic hypotheses are in the null form. Independent variables for all but two hypotheses in this objective are associated with three dependent variable sets: (A) medical service utilization; (B) medical service expenditure; and (C) lost time from work.

Medical service utilization consists of different types of medical services including hospitalizations, outpatient visits, physician visits, emergency department visits, prescriptions, and other types of services. These components are heterogeneous with respect to the resources needed per unit of utilization. Although "medical service utilization" is a concise term used in the following hypotheses, specific statistical analyses were completed as needed for particular medical service utilization components.

Medical expenditure is also a summary measure. Unlike medical service utilization, expenditure items are assessed using a standard unit of measure (i.e., the dollar), thus making overall valuation of medical expenditure more direct.

$H_0$1 There is no relationship between claimant age and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$2 There is no relationship between claimant gender and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$3 There is no relationship between claimant race / ethnicity and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$4 There is no relationship between claimant diagnosis (i.e., as determined by grouper category) and (A) medical service utilization, (B) expenditure, or (C) lost time from work for the claimant. ICD-9 codes for these analyses were selected based on frequency and relevance as identified from the literature.

$H_0$5 There is no relationship between medical procedure code (i.e., CPT-4 codes) and (A) medical service utilization, (B) expenditure, or (C) lost time from work for the claimant. CPT-4 codes for these analyses were selected based on frequency and relevance as identified from the literature.

$H_0$6 There is no relationship between claimant comorbidities and (A) medical service utilization; (B) expenditure; or (C) lost time from work. Claimant comorbidities for these analyses were selected based on frequency and relevance as identified from the literature.

$H_0$7 There is no relationship between claimant location (i.e., city of residence) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$8 There is no relationship between claimant pre-injury wage and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$9 There is no relationship between number of physician visits the claimant makes due to injury and (A) expenditure; or (B) lost time from work.

$H_0$10 There is no relationship between time off work due to injury for the claimant and (A) medical service utilization; or (B) expenditure.

$H_0$11 There is no relationship between the number of pre-injury hours worked per week for a particular claimant prior to the injury and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

3.1.2.4.2. Physician Characteristics

All hypotheses for physician characteristics are in the null form.

$H_0$12 There is no relationship between the gatekeeper physician practice type (i.e., single or group practice) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$13 There is no relationship between gatekeeper physician specialty and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$14 There is no relationship between location in which initial physician service is provided (i.e., emergency department, outpatient department, etc) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$15 There is no relationship between provider type (i.e., allopathic or osteopathic physician vs. chiropractor) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$16 There is no relationship between location of gatekeeper provider (i.e., region of practice setting) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$17 There is no relationship between gatekeeper provider specialization and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

3.1.2.4.3. Other Selected Factors

All hypotheses for other selected factors are in the null form.

$H_0$18 There is no relationship between carrier and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

$H_0$19 There is no relationship between the rate of unemployment in a specific geographic region and (A) medical service utilization; (B) expenditure; or (C) lost time from work.

3.1.2.5. Objective 5

This objective does not have specific hypotheses associated with it.

3.1.2.6. Objective 6

This objective does not have specific hypotheses associated with it. The data analyses for this objective are for exploratory purposes only.

3.1.2.7. Objective 7

This objective does not have specific hypotheses associated with it. This is because it is a cost estimation model and no *a priori* outcomes have been established.

4. Methods

The methods section is sub-divided into four main parts: (1) general methods related to study design, data sources, sample size, and preparation; (2) specific methods related directly to the bivariate analyses; (3) specific methods related to the regression analyses; and (4) specific methods relating to the cost estimations models.

4.1. General Methods

Primary event level data were obtained from TWCC with permission from the Deputy Director for Legal Services. Primary data were used to measure outcomes specific to the Texas WC population. Secondary data were obtained from published reports and research articles and were used to provide supporting evidence on expected expenditure and benefits from other settings.

4.1.1. Study Design

This study employed a retrospective database design using five TWCC databases covering claims that occurred during the calendar year January 1, 2001 to December 31, 2001. The Institutional Review Board for the Protection of Human Research Subjects at the University of Texas at Austin approved this study on January 30, 2004 (IRB number: 2004-01-0045). Approximately 163,771 TWCC claimants and 331,339 claims are represented in the databases. The five databases used in this study include de-identified and anonymous data on claims, claimants, providers, medical charges and diagnoses, and benefits. Each database represents a specific part of the claim history; together these databases form a composite picture of each claim for Texas workers covered during the period.

4.1.1.1. Claims Database

The claims database provides information on an individual claim. Each injury episode is represented as a specific claim in the claims database. For example, if a worker has a low back injury in July and then suffers a hand wound in September, each injury is recorded as a separate and distinct claim and is assigned a unique claim identifier. Examples of data collected in this database include injury type and body part, date claim reported, indemnity information, and number of days worked per week prior to claim submission. Table 2 details variables used in this study from the claims database.

Table 2: Descriptive details of variables used in this study from the claims database

	Variable Name	Description
Claims Database	Claim ID	This is the identification number for a specific claim. This number is de-identified and encrypted.
	Claimant ID	This is the identification number of a specific claimant. This number is de-identified and encrypted.
	Monthly wage	The actual monthly wage amount of the claimant prior to the claim
	Average monthly wage	The average monthly wage amount of the claimant prior to the claim
	Days worked per week	The number of days worked per week prior to the injury
	Injury source	Source of injury (e.g., ankle, arm, etc.)
	Injury nature	Nature of injury (e.g., sprain, strain, etc.)
	Date reported to employer	Date the claimant reports the accident to the employer
	Date disability began	Date disability began
	Data claim established	Date the claim is established
	Return to work date	Date the claimant first returns to work
	Physician city	City of the physician who provided this particular claim; this may be different than the provider (i.e., gatekeeper) physician.
	Physician zip code	Zip code of the physician who provided this particular claim; this may be different than the provider (i.e., gatekeeper) physician.
	Provider ID	The provider's unique identifier. This number is de-identified and encrypted. Note: this is not physician's license number.
	Claim average week wage	This is an average wage based on the last 13 months of employment income. This value is used to establish workers compensation payments.

4.1.1.2. Claimant Database

The claimant database provides demographic and other information on the injured worker (i.e., claimant). Each claimant has a unique claimant identification number (that is de-identified and encrypted in this study). The insurance carrier representing the worker and employer supplies this information to TWCC. There are 43 unique data fields (i.e., variables) available in this database. Examples of data collected in this database include claimant age, gender, race, and city of residence. For this study, only a subset of variables is required; they are described in detail in Table 3.

Table 3: Descriptive details of variables used in this study from the claimant database

	Variable Name	Description
Claimant Database	Birth date	Birth date is used to calculate the age of the individual
	Resident city	The city in which the resident resides
	Resident zip code	The zip code in which the resident residents
	Gender	Self-explanatory
	Claimant ID	This is the identification number for a specific claimant. This number is de-identified and encrypted.
	Race	Based on skin color
	Ethnicity	Self-described ethnic origin as Hispanic or non-Hispanic

4.1.1.3. Medical Information Database

This database provides treatment information (i.e., medical billing, diagnoses, etc.) submitted by the insurance carrier for a particular claim. Treatment information may be based on a visit to any provider (e.g., hospital or physician) for which payment is subsequently due. There are more than 50 unique data fields (i.e., variables) available in this database. Examples of data collected in this database include diagnosis codes (i.e., ICD-9 codes), procedure codes (i.e., CPT-4 codes), payment information, and service dates. For this study, only a subset of variables is required; they are described in detail in Table 4.

Table 4: Descriptive details of variables used in this study from the medical information database

	Variable Name	Description
Medical Information Database	Bill type	This identifies the type of facility (e.g., hospital, physicians office) and whether this is the final or interim bill.
	Claim ID	This is the identification number of a specific claim. This number is de-identified and encrypted.
	CPT-4 code	The first medical procedure code provided
	ICD-9 code	The initial medical diagnosis code provided
	Admit date	Admission date for hospitalization
	Carrier Name	The unique identifier for each insurer. This number is de-identified and encrypted.
	Days quantity supplied	Days of service provided or quantity of supplies (units) provided
	Physician type code	Provider type (e.g., MD, doctor of chiropractor (DC), etc.)
	Served from date	Date billing began
	Served to date	Date billing ended
	Pay amount	Amount the insurance carrier paid to the provider
	Charge amount	The usual and customary amount the provider billed the insurance carrier. This is not necessarily the same as “pay amount.”
	Exception code	The reason for the difference between a charge and payment if the carrier does not reimburse for the full charge.
	Service location	Where the service took place (e.g., ER, OPD, etc.).
	Physician License Number	The state license number of the physician. This number is de-identified and encrypted.

4.1.1.4. Provider Database

This database provides demographic and practice-related information on the provider. It is linked to the medical database by the physician license number (which is de-identified and encrypted) in this study. There are 19 unique data fields (i.e., variables) available in this database. Examples of data collected in this database include: provider type, specialty, and practice location (by city and zip code). For this study, only a subset of variables is required; they are described in detail in Table 5.

Table 5: Descriptive details of variables used in this study from the provider database.

	Variable Name	Description
Provider Database	Provider ID	The provider's unique identifier. This number is de-identified and encrypted.
	Provider type	The type of provider (e.g., MD, DC, etc.)
	Claim ID	This is the identification number of a specific claim. This number is de-identified and encrypted.
	Provider specialty	The physician's specialty code (e.g., family practice, obstetrician, general surgeon, etc).
	Physician License #	The state license number of the physician. This number is de-identified and encrypted.
	Provider city	City in which the primary provider (i.e., gatekeeper) is located.
	Provider zip code	Zip code of the primary provider (i.e., gatekeeper) location.

4.1.1.5. Benefit Database

This database provides information related to benefits provided to each claimant with a claim period of greater than seven days. Examples of data collected in this database include pre-injury weekly wage, income compensation rate, and number of weeks benefits were received. A listing of variables in this database was not provided by TWCC.

4.1.2. Considerations When Using Database Records for Research

Using database records for research purposes may be both beneficial and disadvantageous. Chief among the benefits of using a database is that records are often readily available, extensive in scope, provide methodological flexibility, and usually have a large enough patient population to meet sample size and power requirements.[133] Indeed, database records can often provide a good opportunity to conduct research when other epidemiological methods (e.g., enrolling individuals in a trial or conducting survey research) are too expensive or time consuming. For this study, database records are used as a practical, economical method of assessing patient outcomes, utilization, and expenditures. However, there are limitations associated with database research.

4.1.3. General Limitations for Database Research

Limitations to database research include threats to internal, construct, and external validity. One such internal validity threat directly related to this study is incorrect, missing, or improper diagnostic and procedural coding that may render data unreliable or invalid.[134,135,136] Coding problems can manifest as under- or over-coding for a particular illness or as the inability of a particular database field to accommodate all patient

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[133] Motheral BR, Fairman KA. The use of claims databases for outcomes research: rationale, challenges, and strategies. *Clinical Therapeutics* 1997;19(2):346-366.
[134] Lohr KN. Use of insurance claim data in measuring quality of care. *International Journal of Technology Assessment in Health Care* 1990;6(2):263-271.
[135] Jollis JG, Ancukiewicz M, DeLong ER, *et al*. Discordance of databases designed for claims payment versus clinical information systems. Implications for outcomes research. *Annals of Internal Medicine* 1993;119(8):844-850.
[136] Romano PS, Luft HS. Getting the most out of messy data: problems and approaches for dealing with large administrative data sets. In: ML Grady, HA Schwartz, eds. Medical Effectiveness Research Data Methods: Summary Report. AHCPR Publication No. 92-0056. Rockville, MD: US Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research. 1992;57-55.

diagnostic and procedure codes. For example, a database field may only allow coding for up to three procedure codes, even though the patient may have more than three procedures completed.

Another potential threat to internal validity of concern to this study is confounding. A confounding factor is "any uncontrolled variable that systematically varies with [the] independent variable."[137] If a confounding variable is present one "cannot say unambiguously" that variation or changes in the dependent variable were not due to the confounding factor.[138] Therefore, considerable planning beforehand is important to identify confounding variables so that they may be properly controlled for during statistical analyses. Potential confounders in this study included: age of patient, injury severity, type of work, physician specialty (e.g., family practice vs. occupational medicine physician), provider type (e.g., MD vs. DC), insurer, and urban vs. rural location.

Threats to external validity, or being able to make generalizations about the findings of the study population to the population at large, also occur in database studies. For example, it is important to recognize the unique characteristics of the population being studied. In addition, there may be regional practice variations that may influence medical utilization and expenditure. Likewise, there may be cost differences across the state due

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[137] Bordens KS and Abbott BB (1991). Choosing a research design. Research Design and Methods: A Process Approach. Mountain View, CA, Mayfield Publishing Company: 57-81.
[138] *Ibid.*

to factors outside of the WC system (e.g., cost of living). Threats to construct validity, or the degree to which a variable measures what it purports to measure, may also occur.

4.1.4. Specific Limitations to This Study

In addition to the general limitations of database studies mentioned above, there are some specific limitations associated with this study.

- The TWCC databases were not developed to collect data for claims analysis. Rather, these databases were created as a repository for workers' compensation data on workplace injuries in the state Texas.
- Database entries may not accurately reflect the actual injury (e.g., a wrong ICD-9 diagnosis code may be assigned at time of initial physician contact).
- There may be coding errors at data entry (e.g., the wrong ICD-9 code may be entered).
- The TWCC databases do not allow for complete data entry for comorbid conditions beyond three ICD-9 codes, thus limiting the extent to which comorbidities can be considered during the analysis phase.
- The database provides no information on patient compliance with physician instructions, rehabilitation activities, or return to work assessments.
- TWCC databases only capture reported injuries. The extent to which workers are injured at work, but are not reported to TWCC, are not available for analysis.
- This database, at a minimum, only captures data from companies that provide WC coverage. Employers who do not provide WC coverage are required by Texas

state law to report information on work-place injuries. The extent to which non-participating employers report this information is unknown.

- The one-year time period used in this study may not accurately reflect long-term claim trends among injured workers in the state of Texas.

4.1.5. Study Population

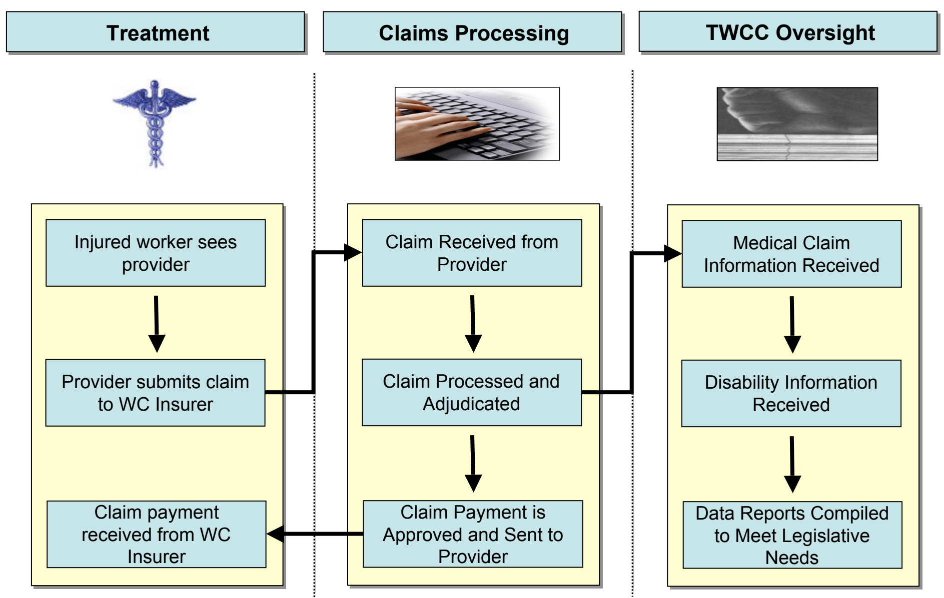
The study population consists of workers who were injured on the job in the state of Texas from January 1, 2001 to December 31, 2001 and who had their illness or injury covered by workers' compensation insurance. However, not all workers in the state of Texas who suffered an occupational injury or illness during the defined period are included. This is because Texas does not mandate employer participation in the workers' compensation program. It is estimated that 35 percent, or 1.4 million Texas workers were not covered by workers' compensation insurance in 2001.[139]

Injured workers covered by WC insurance are free to have treatment provided by the provider of their choice. In turn, the provider decides on the type and extent of care (e.g., rehabilitation, surgery, delayed return to work, etc.) the patient should receive. To receive payment, the provider (i.e., this includes both physicians and hospitals) submits a bill to the insurance company providing WC coverage. In turn, the provider is reimbursed a specific amount based on TWCC rules and regulations. At this time, there

[139] Shields J and Campbell DC. A study of non-subscription to the Texas Workers' Compensation System. Research and Oversight Council. Austin February 2002.

is no limit on the types or extent of service a WC patient can receive. WC insurance carriers are required to report claim and claimant information to TWCC. The WC treatment, claims processing, and TWCC oversight activities are depicted in Figure 6.

Figure 6: The claims flow process for work-related injuries in Texas.



4.1.6. <u>General Inclusion and Exclusion Criteria</u>

Existing records from the five TWCC databases described above were used. All claimants reporting a claim between January 1, 2001 and December 31, 2001 were included, whether or not the claim was closed during that time period. The open claims method was chosen because it provides a more complete picture of WC utilization and expenditure in Texas than just examining completed claims. Claimants aged 18 to 85years were included. As an added precaution to protect patient identity, claimants greater than 85 years of age were excluded, yet this is not likely to affect overall outcomes since claims from those greater than 85 years of age are expected to represent only a fraction of total WC claims. Both male and female workers are included in this study. Claims lasting less than one week were excluded since they represent a very small portion of costs associated with WC and because WC claims of less than a week do not incur indemnity costs.

4.1.7. Sample Size and Power

The purpose of a power analysis is to determine the sample size needed to detect a specific effect size at a particular power level. In this study, the ability of a specific statistical test to detect an effect size (ES) of 0.02 at a minimum power of 80 percent is estimated. The very small ES of 0.02 was chosen for this *a priori* power analysis because the number of subjects estimated to be in the TWCC database is very large (approximately 200,000). However, it should be noted that many of the analyses are expected to attain a statistically significant result despite using a very conservative alpha. Therefore all results were interpreted based not only on statistical significance, but also on whether the results were deemed to be practically significant.

T-Test

This test has an 80 percent power to detect an ES of 0.02 at an alpha level of 0.001 for two groups with balanced cell sizes of 75,000.

ANOVA

This test has an 82 percent power to detect an ES of 0.02 at an alpha level of 0.001 for 11,000 cases per cell in four cells.

Correlation

This test has an 88 percent power to detect an ES of 0.02 at an alpha level of 0.001 for a sample size of 50,000.

Logistic Regression

This test has an 81 percent power to detect an ES of 0.01 at an alpha level of 0.001 for a sample size of 65,000.

Thus, it appears that the large sample size available from the TWCC database will be sufficient to detect very small ES values for the statistical tests planned in this study. Since it is likely that the statistical tests will yield significant results even with very small ES values, care was taken to interpret the results in terms of both statistical and practical significance.

4.1.8. Data Analysis

Data manipulation and analyses were performed using SPSS and Microsoft Excel software. Where appropriate, parametric or non-parametric tests were used, depending on whether the distribution meets normality assumptions. Because of the large sample size, the *a priori* significance level is set to 0.001. As necessary, some data were converted to a natural logarithm prior to analysis. Details of specific statistical procedures and data manipulations are discussed below.

4.1.9. Statistical Procedures

The statistical procedures used in this study are presented in Table 6. In this table, the specific objective, hypotheses, and statistical procedures are presented.

Table 6: Statistical procedures used during this study for each hypothesis and objective

Objective	Hypothesis	Statistical Procedure
1. Identify current literature on lost time, disability management, and system expenditures related to workers' compensation injury and disability	This objective does not have specific hypotheses associated with it.	Not applicable
2. Identify and review time loss and disability management programs in other settings and to determine their relevance and feasibility for use in Texas	This objective does not have specific hypotheses associated with it.	Not applicable
3. Profile Texas Workers' Compensation Claimants and Providers from January 1, 2001 to December 31, 2001	This objective does not have specific hypotheses associated with it.	Not applicable
4. Determine if patient characteristics, physician characteristics, and other selected factors are associated with medical service utilization, expenditure, and work loss	**$H_0$1** There is no relationship between claimant age and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Pearson correlation (B) Pearson correlation (C) Pearson correlation
	$H_0$2 There is no relationship between claimant gender and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) T-test (B) T-test (C) T-test
	$H_0$3 There is no relationship between claimant race / ethnicity and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
	$H_0$4 There is no relationship between claimant diagnosis (i.e., as determined by grouper category) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) One-way ANOVA with post hoc analyses (B) One-way ANOVA with post hoc analyses (C) One-way ANOVA with post hoc analyses
	$H_0$5 There is no relationship between medical procedure code (i.e., CPT-4 codes) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable

Objective	Hypothesis	Statistical Procedure
Objective 4 (Continued)	**$H_0$6** There is no relationship between claimant comorbidities and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
	$H_0$7 There is no relationship between claimant location (i.e., city of residence) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
	$H_0$8 There is no relationship between pre-injury wage and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Pearson correlation (B) Pearson correlation (C) Pearson correlation
	$H_0$9 There is no relationship between number of physician visits the claimant makes due to injury and (A) expenditure; or (B) lost time from work.	(A) Pearson correlation (B) Pearson correlation
	$H_0$10 There is no relationship between time off work due to injury for the claimant and (A) medical service utilization; or (B) expenditure.	(A) Pearson correlation (B) Pearson correlation
	$H_0$11 There is no relationship between the number of hours worked per week for a particular claimant prior to injury and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
	$H_0$12 There is no relationship between gatekeeper physician practice type (i.e., single or group practice) and (A) medical service utilization; (B) expenditure; or (C) lost time from work.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
	$H_0$13 There is no relationship between gatekeeper physician specialty and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable

Objective	Hypothesis	Statistical Procedure
	$H_0$14 There is no relationship between location in which initial physician service is provided (i.e., emergency department, outpatient department, etc) and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) One-way ANOVA with post hoc (B) One-way ANOVA with post hoc (C) One-way ANOVA with post hoc
	$H_0$15 There is no relationship between provider type (i.e., allopathic or osteopathic physician vs. chiropractor) and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) One-way ANOVA with post hoc & repeated measures ANOVA (B) One-way ANOVA with post hoc & repeated measures ANOVA (C) One-way ANOVA with post hoc & repeated measures ANOVA
	$H_0$16 There is no relationship between the TWCC region of service of where the medical care is provided and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) One-way ANOVA with post hoc (B) One-way ANOVA with post hoc (C) One-way ANOVA with post hoc
	$H_0$17 There is no relationship between specialization of gatekeeper provider and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
	$H_0$18 There is no relationship between carriers and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) One-way ANOVA with post hoc (B) One-way ANOVA with post hoc (C) One-way ANOVA with post hoc
	$H_0$19 There is no relationship between regional rates of unemployment and (A) medical service utilization; (B) expenditure; or (C) lost time from work for the claimant.	(A) Did not complete because of lack of data on the independent variable (B) Did not complete because of lack of data on the independent variable (C) Did not complete because of lack of data on the independent variable
5. Identify patient characteristics, physician characteristics, and other selected factors associated with high medical service utilization, expenditure, and work loss	This objective does not have specific hypotheses associated with it.	Multiple regression

Objective	Hypothesis	Statistical Procedure
6. Develop models to predict medical service utilization, expenditure, and work loss based on patient characteristics, physician characteristics, and other selected factors	This objective does not have specific hypotheses associated with it.	Multiple regression
7. Predict changes in system cost and utilization patterns after implementing evidence-based disability management programs based on the literature	This objective does not have specific hypotheses associated with it.	Not applicable

4.1.10. Data Preparation

TWCC provided five data files for analysis: (1) claim data; (2) claimant data; (3) medical information data; (4) provider data; and (5) benefits data. Prior to analysis, data were reviewed to identify data distribution, outliers, and anomalies of the data that would lead it to be considered outside of the norm. To minimize bias, data values judged to be unreasonable were omitted from the analyses as described below. Definitions of key variables are noted in Table 7.

Table 7: Definitions of key variables

Variable	Definition
Office visit	A visit by an injured worker to a physician's office resulting in a consultation with the physician. An office visit designation is based on CPT-4 code billing. Examples of what constitutes an office visit: • A patient has a consultation with the same physician on the same day with multiple CPT-4 codes (e.g., a CPT-4 code for initial consultation and an additional code for prolonged physician service). This would count as one office visit. • A patient has visits with two separate physicians on the same day resulting in CPT-4 consultation codes from each physician. This would count as two office visit. (Note: Visits to a physician's office that do not involve a physician consultation (e.g., going to the physician's office for lab work were not counted as an office visit)).
Hospital visit	A visit by an injured worker to an inpatient hospital setting based on an admission date to the facility. This does not include visits to the emergency department.
Emergency department visit	A visit by an injured worker to an emergency department (ED) that resulted in a consultation with a physician. An ED visit designation is based on CPT-4 codes designating an emergency department service.
Elsewhere	A visit by the injured worker to an office-based setting that does not include consultation with a physician. This could include going to the physician's office for ancillary services (e.g., lab work, radiographs, etc.) or to another provider for chronic care (e.g., occupational therapy). These visits are based on CPT-4 code billing.
Payment	Payments associated with a particular claim. Payments include all physician, hospital, ancillary, and related costs associated with the injury.
Income benefit	All income benefits associated with a particular claim. This may include temporary income benefits (TIB), impairment income benefits (IIB), supplementary income benefits (SIBs), and lifetime benefits, depending on the claim.
Weekly wage	The pre-injury weekly wage for the claimant that is used as a basis for determining the income benefit for this worker.
Weeks of income benefits	The number of weeks in which the claimant receives lost time benefits. A claimant can receive income benefits for a maximum of 405 weeks.

Variable	Definition
Diagnostic category	An assigned injury group based on primary ICD-9 diagnosis (see the Appendix for diagnostic grouper information).
TWCC service range	One of four geographic service regions classified by TWCC. The four regions are: • Region 1 (North): Dallas / Ft. Worth / Waco • Region 2 (East): Houston / Galveston / College Station • Region 3 (South): Austin / San Antonio • Region 4 (West): El Paso / Lubbock / San Angelo

4.1.10.1. Age Range

In Texas, workers are generally allowed to begin legal employment at the age of 14.[140] There are no restrictions on when an employee must retire for most occupations. The age range for this study ranges from age 14 to 85. Eighty-five was selected as the maximum age limit because it is high enough to include the majority of Texas workers and is a reasonable approximation of the Texas workforce. Limiting the analysis to the 14 – 85 range includes approximately 98% of all Texas workers with WC claims during the study period. Claimants not included in this age range were removed from the data set and were not analyzed.

4.1.10.2. Weekly Wage

Several of the bivariate analyses described in section 5.2 use weekly wage as a variable of interest. This variable reports the pre-injury weekly wage of the injured worker. Examination of the variable distribution showed that wage data is positively skewed. Cut-off points were established to exclude potentially unreasonable weekly wage data.

[140] Texas State Code. Minimum Age Statutes. Labor Act. 51.011. Available: www.capitol.state.tx.us. Accessed: January 24, 2004.

The researchers established a minimum weekly wage of \$25. The rationale is that some employees may work only a few hours each week at minimum wage (e.g., a high school student working an after-school job). Weekly wage values less than \$25 (n = 6,323) were excluded from the analyses. Other variables associated with cases having a weekly wage value of less than \$25 were not removed from the dataset.

The maximum weekly wage established for this study is based on: (1) the claimant receiving the maximum temporary income benefit; and (2) receiving a weekly wage that is four standard deviations above the mean weekly wage (of the raw data values for this variable), or a value of \$3,112. The rationale for basing the maximum weekly wage on two factors is that it is possible for wage earners to earn greater than four times the standard deviation of the weekly wage and receive WC. However, such workers would also be expected to receive the maximum WC weekly temporary income benefit (TIB). If a worker has a pre-injury weekly wage of \$3,112 yet does not receive the maximum TIBs compensation rate, the information in the database is likely to be inaccurate. To prevent "false" results, all claimants with weekly wage values greater than \$3,112 and who do not have corresponding maximum TIBs compensation rates at the 2001 maximum level or above will not be evaluated. Of the 90 claims with weekly wages exceeding four standard deviations above the mean, 58 were removed from the analyses involving weekly wage because they did not also have a corresponding benefit payment equal to the maximum possible value (≥ \$533). Note, however, that the other variables associated with these 58 cases were not removed from the dataset. The remaining 32 claims were included because they did not meet both exclusion criteria. Weekly wage values were converted to the natural log format due to positive skewing associated with financial data. Therefore, all analyses involving weekly wage data are computed using the log; however, actual wage values are provided for comparison purposes. In order to make sure that all log values were calculated properly, the value of \$1.00 was added to all medical service payment values to ensure that there would be no "log of 0.00" values. The additional \$1.00 added to each medical service payment is unlikely to have altered the results significantly.

4.1.10.3. Number of Weeks Benefits Received

Indemnity benefits are subject to specific monetary and time restrictions based on TWCC rules and regulations. These benefits are paid under a variety of benefit headings, depending on the type, severity, and length of injury. Excluding lifetime benefits, a claimant can only receive income benefits for a maximum of 405 weeks. All claims greater than 405 weeks were removed (n=84). However, most of these "excessive claims" were due to incorrect start or stop dates (e.g., a claim was started on July 10, 2001 and was reported to have ended on August 30, 2010, which is far beyond the timeframe of this current study). Clearly some of these stop dates were anomalies. Yet, to ensure consistency, data on the number of weeks benefits were received for these "excessive claims" were removed. Other variables associated with these claims, however, were not removed from the analyses.

4.1.10.4. Lost Time Benefit

The total lost time benefit payment provided to any one worker is based on a combination of factors. These factors include type of injury, injury severity, amount of time off work, and the ability to return to work in the same or similar position. The primary cost driver for total lost time payment is the temporary income benefit (TIB). Indeed, the majority of lost time benefits in this study represented TIB benefits. However, supplemental income benefits (SIB) were also paid to some claimants. TIBs are assigned after the injured worker has remained off work for greater than seven days and can remain in place for a maximum of 104 weeks with appropriate documentation and approval. During the study period, the maximum TIB payment per week was $533.[141] SIB payments have a maximum per weekly payment of approximately $400 per week and can be activated for a maximum period of 364 weeks, or seven years.

Total lost time payments cannot exceed a certain amount. However, because each individual claim is different, the upper limit varies according to individual circumstances. Examination of the original data showed that total lost time payment values ranged from $0 to $9,478,362. The maximum value is clearly an anomaly, yet because of the administrative and self-reported nature (by carrier) of this data, it is difficult to identify specific reasons for the anomaly. To provide more confidence in the available data, all total lost time payment values greater than four standard deviations above the mean ($6,826 ± $43,617, or $181,294) were removed from analyses involving total lost time payments. Four standard deviations were chosen in order to be as inclusive as possible for all data; any values lying outside four standard deviations were deemed to be sufficiently anomalous to not be included. Of 83,472 claims with lost time data, 26 had values greater than $181,294; these values were excluded

[141] Texas Workers' Compensation Commission. Maximum and Minimum Weekly Benefits, Texas Workers' Compensation Commission. 2004.

from analyses involving total lost time payments. Note, however, that other variables associated with these 26 claims were not removed from the dataset. Lost time benefit values were converted to the natural log format due to positive skewing associated with financial data. Therefore, all analyses involving lost time benefit data are computed using the log; however, actual lost time values are provided for comparison purposes. In order to make sure that all log values were calculated properly, the value of $1.00 was added to all medical service payment values to ensure that there would be no “log of 0.00” values. The additional $1.00 added to each medical service payment is unlikely to have altered the results significantly.

4.1.10.5. Diagnostic Categories

Diagnostic categories are used to identify specific types of injuries based on ICD-9 codes. For example, skeletal trauma to the ankle and foot includes at least four ICD-9 codes (837.0, 837.1, 838.0, and 838.1). In order to better identify similar injuries, diagnostic grouping categories that aggregate ICD-9 codes related to a particular injury type under one heading were used. In this case, these four ICD-9 codes are represented by disease grouper category 1109. All primary ICD-9 codes were assigned to one of the 171 diagnostic grouper categories provided TWCC. The diagnostic grouper categories were provided by TWCC and are listed in the Appendix B.

4.1.10.6. Medical Service Payment

Payment was used to determine the medical expenditure for each claim. This included payments for physician services, medical supplies, hospitalizations, and other medical services. Fifty-one claims had total payments that were negative (ranging from -\$2.12 to -\$22,677.30; total = -\$38,456). A negative payment amount may be due to a variety reasons related to overpayment (e.g., unnecessary treatment following peer review, inappropriate documentation of services, denial after reconsideration, dispute, etc.). Negative values were set to zero. Medical service payment values were converted to the natural log format due to positive skewing associated with financial data. Therefore, all analyses involving medical service payment data are computed using the log; however, actual medical service payment values are provided for comparison purposes. In order to make sure that all log values were calculated properly, the value of \$1.00 was added to all medical service payment values to ensure that there would be no "log of 0.00" values. The additional \$1.00 added to each medical service payment is unlikely to have altered the results significantly.

4.2. Bivariate Analyses Methods

For this section, the relationships between a particular independent variable and select outcome variables were determined. In this current study, independent variables are used to describe the expected variation in medical service utilization, medical and lost time expenditure, and time off from work. Table 8 provides a list of independent variables used in this study and types of questions that can be answered.

Table 8: Independent and dependent variables used in this study

Independent Variable	Dependent Variables	Types of Questions to Ask
Age	Medical service utilization Expenditure Time off from work	What are the relationships between age and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Gender	Medical service utilization Expenditure Time off from work	What are the relationships between gender and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Claimant diagnosis code	Medical service utilization Expenditure Time off from work	What are the relationships between injury type and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Pre-injury wage	Medical service utilization Expenditure Time off from work	What are the relationships between pre-injury wage and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Number of office visits	Expenditure Time off from work	What are the relationships between the number of office visits and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Number of weeks of work	Medical service utilization Expenditure Time off from work	What are the relationships between the number of weeks off work for an injured worker and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Location of initial physician visit	Medical service utilization Expenditure Time off from work	What are the relationships between the place of initial physician visit and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Provider type	Medical service utilization Expenditure Time off from work	What are the relationships between provider type (e.g., MD, DC, PT) and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
TWCC region of service	Medical service utilization Expenditure Time off from work	What are the relationships between the location (by TWCC service region) of treatment and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?
Carrier	Medical service utilization Expenditure Time off from work	What are the relationships between carrier type and medical service utilization, expenditure, and time off work due to work-related injuries in Texas?

4.2.1. Rationale for Conducting Bivariate Analyses

The independent variables were chosen because of data availability and research interest. Conducting bivariate analyses to assess the relationship between independent and dependent variables allows potential relationships to be identified and further explored using other statistical techniques. That is, each of the 10 independent variables may be a predictor of system use in and of themselves. For example, the TWCC region in which medical care is provided may say more about medical service utilization, expenditure, and time off work than the injury itself. Likewise, age may be a greater predictor of medical service utilization than actual injury.

4.2.2. Statistical Tests Used for Conducting Bivariate Analyses

The type of statistical test used to conduct a particular bivariate analysis is based on several factors including the question asked, research design, and type of data available for analysis. In this study, three types of statistical tests were used to conduct bivariate analyses. Despite using different statistical tests, the task of assessing the relationship between the independent variable and dependent variable remains the same. Each of the three tests used to assess bivariate relationships are discussed below.

Pearson Correlation: A Pearson Correlation is used to determine the degree to which the two variables show a relationship with each other. The strength of the correlation is measured by a correlation coefficient that ranges in value from 0 to 1. A correlation coefficient from 0.0 to 0.4 is considered weak, from 0.4 to 0.7 is moderate, and above 0.7 is strong.

Student T-Test: Unlike the Pearson Correlation, the T-test does not determine a correlation between the independent and dependent variables. Rather, it assesses the mean differences in outcome of the dependent variable among the independent variable to determine the probability that an event may be caused by the independent variable. For example, in order to determine the relationship between the number of weeks off work between men and women, the T-test compares the mean number of weeks off work for both males and females (i.e., 17.91 vs. 20.01). In this case, the difference in mean number of weeks off work is 2.10 higher in females than males. This difference is statistically significant at $p < 0.001$ meaning that women, on average, have slightly more than two weeks time off work than men due to injuries and that this difference is 99.99% not likely due to chance alone.

One Way Analysis of Variance (ANOVA): The one-way ANOVA assesses the relationship between an independent variable with multiple categories (e.g., the TWCC region in which care is delivered) and the dependent variable. The results of a one-way ANOVA come in two parts. The first part reports the results of the omnibus F-test. This result identifies whether there are any statistically significant differences between any of the categories of the independent variable for each dependent variable. For example, the omnibus F-test will compare the mean medical service expenditure for each TWCC region and determine if there are any differences in medical service expenditure among the regions. If the mean difference between any of the four regions reaches statistical significance, then the omnibus F-test will report a statistically significant result. The second part, a post-hoc result, reports the mean differences between the different categories (e.g., the mean medical expenditure in TWCC region 1 is $XXX.XX higher than in region 2, but only $YYY.YY higher than in region 3). Continuing the example from above if the omnibus F-test shows a statistical difference among TWCC regions of service for expenditure, the second part, or post-hoc tests, will identify where between which groups the differences exist.

4.3. Regression Analyses Methods

The regression analyses were conducted for exploratory purposes only. As such, the step-wise method was used to identify the best-fit model for each of the eight dependent variables chosen. These eight dependent variables represented payment, medical service utilization, and time off from work outcomes for TWCC claimants. The step-wise probability to include a variable in the model and to remove a variable from the model was $\alpha = 0.001$. Twenty-two independent variables were available for step-wise entry, unless one of the independent variables was directly correlated with the dependent variable (e.g., if the dependent variable was number of hospitalizations, an independent variable measuring the same category would not be included). All categorical data were dummy coded in order to develop "mutually exclusive and exhaustive categories."[142] Table 9 identifies the dependent and independent variables used in this study as well as the reference group for dummy coded variables. The independent variables identified for inclusion were all statistically significant at $p \leq 0.001$ in the bivariate analyses.

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[142] Hardy M (1993). Regression with dummy variables. Iowa City, IA, Sage University Press: p.7.

Table 9: Description of variables used in the regression analyses

Variable Name	Variable Type	Variable Code	Other Information and / or Dummy Code Reference Category
Office Visit	DV	OV	Outcome variable for predicting number of office visits
Hospitalization	DV	Hosp	Outcome variable for predicting number of hospitalizations
Emergency Dept. Visit	DV	EDV	Outcome variable for predicting number of emergency department visits
Other Office Visit	DV	Other	Outcome variable for predicting number of visits elsewhere (i.e., non-MD office visits)
Log of Medical Payment	DV	Med	Outcome variable for predicting log of medical payment
Log of Indemnity Payment	DV	Ind	Outcome variable for predicting log of indemnity payment
Log of Total Payment	DV	Tot	Outcome variable for predicting log of total payment (i.e., medical plus indemnity)
Number of Weeks off Work	DV	Wks	Outcome variable for predicting number of weeks off work
Log of weekly wage prior to injury	IV	Wage	Continuous predictor variable used in all regression analyses
Female gender	IV	Fem	Categorical predictor variable used in all regression analyses. Male gender is the reference group.
Dallas TWCC region	IV	Dallas	Categorical predictor variable used in all regression analyses. The El Paso / West Texas region is the reference group.
Houston TWCC region	IV	Houston	Categorical predictor variable used in all regression analyses. The El Paso / West Texas region is the reference group.
Austin / San Antonio TWCC region	IV	A/SA	Categorical predictor variable used in all regression analyses. The El Paso / West Texas region is the reference group.
Diagnostic Grouper 302 – Neck strain / sprain	IV	302	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the “top-ten” by frequency of injury are the reference group.
Diagnostic Grouper 501 – Low back regional pain	IV	501	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the “top-ten” by frequency of injury are the reference group.
Diagnostic Grouper 502 – Low back strain / sprain	IV	502	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the “top-ten” by frequency of injury are the reference group.
Diagnostic Grouper 602 – Shoulder strain / sprain	IV	602	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the “top-ten” by frequency of injury are the reference group.
Diagnostic Grouper 802 – Hand / wrist strain /sprain	IV	802	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the “top-ten” by frequency of injury are the reference group.
Diagnostic Grouper 807 – Hand / wrist abrasion / contusion	IV	807	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the “top-ten” by frequency of injury are the reference group.

Variable Name	Variable Type	Variable Code	Other Information and / or Dummy Code Reference Category
Diagnostic Grouper 808 – Hand / wrist laceration	IV	808	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the "top-ten" by frequency of injury are the reference group.
Diagnostic Grouper 810 – hand / wrist fracture	IV	810	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the "top-ten" by frequency of injury are the reference group.
Diagnostic Grouper 1004 – Knee / tendon ligament rupture	IV	1004	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the "top-ten" by frequency of injury are the reference group.
Diagnostic Grouper 1102 – Ankle / foot strain / sprain	IV	1102	Categorical predictor variable used in all regression analyses. Diagnostic categories that do not fall within the "top-ten" by frequency of injury are the reference group.
MD office visit	IV	MD	Categorical predictor variable used in all regression analyses except when OV is the dependent variable. The reference group is all locations except MD and ED.
Emergency Dept. Visit	IV	ED	Categorical predictor variable used in all regression analyses except when EDV is the dependent variable. The reference group is all locations except MD and ED.
Carrier 1	IV	C1	Categorical predictor variable used in all regression analyses. The reference group is all carriers that are not a "top-five" insurance carrier by number of claims.
Carrier 2	IV	C2	Categorical predictor variable used in all regression analyses. The reference group is all carriers that are not a "top-five" insurance carrier by number of claims.
Carrier 3	IV	C3	Categorical predictor variable used in all regression analyses. The reference group is all carriers that are not a "top-five" insurance carrier by number of claims.
Carrier 4	IV	C4	Categorical predictor variable used in all regression analyses. The reference group is all carriers that are not a "top-five" insurance carrier by number of claims.
Carrier 5	IV	C5	Categorical predictor variable used in all regression analyses. The reference group is all carriers that are not a "top-five" insurance carrier by number of claims.

DV = dependent (or outcome) variable; IV = independent (or predictor) variable.

4.4. Cost Estimation Model Methods

This section discusses methods used to develop the cost estimation model. There are three parts to developing the cost estimation model: (1) calculating *long-term extrapolations* for a series of DM interventions based on *short-term studies* involving DM interventions; (2) identifying costs associated with implementing a DM system; and (3) calculating 10-year estimations of TWCC data using the long-term extrapolations calculated in part one.

4.4.1. Part 1 – Calculating Long-Term Extrapolations Using Short-Term Data

4.4.1.1. Approach to Identifying Cost Reductions for a Group of DM Interventions

Five studies provided information on cost reductions associated with DM interventions.[143,144,145,146,147] However, these studies differed in the types of DM interventions used, how the interventions were used, and the claim inclusion criteria. In turn, these differences influenced health outcomes and overall cost reductions. In order to compare cost reduction trends associated with specific DM interventions between

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[143] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.
[144] Arnetz BB, Sjögren B, Rydèhn B and Meisel R. Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study. *Journal of Occupational and Environmental Medicine* 2003;45(5):499-506.
[145] Baldwin ML, Johnson WG and Marcus SC. Effects of provider networks on health care costs for workers with short-term injuries. *Medical Care* 2002;40(8):686-695.
[146] Cheadle A, Wickizer TM, Franklin G*, et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project 2: medical and disability costs. *Medical Care* 1999;37(10):982-993.
[147] Lemstra M and Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in Workers' Compensation claims: part 2. *Spine* 2004;29(14):1573-1579.

studies, it was necessary to understand these differences and how they are likely to influence results. Therefore, the following approach was used to identify cost reductions for groups of DM interventions.

(1) **Classify studies based on duration of follow-up.** Identify studies as either having a short-term duration (i.e., three years or less) or long-term duration (i.e., greater than three years).

(2) **Select a long-term study to serve as a "baseline" marker.** Identify and select a robust long-term study that can serve as a baseline marker for positing long-term cost reductions using short-term study findings (see step 5 below).

(3) **Identify and classify DM interventions for each study.** Identify DM interventions used in each study and report the strength of each DM intervention relative to the baseline study identified in step 2. Relative strengths of individual DM interventions are determined based on information provided by the study. For example, if the study reports that occupational medicine was used in some circumstances, the strength of this intervention would be compared to the use of occupational medicine in the baseline study. In essence, this identifies the types of interventions used and how these interventions were used. The rationale is that while two studies may use the same intervention, they may use them differently, which will, in turn, influence cost reductions.

(4) **Report the percent cost reduction associated with each study.** Report component reductions for utilization, medical, indemnity, and total costs.

(5) **Report the average per annum cost reductions associated with each study.** Report the total percent cost reduction per annum for each study based on the total percent cost reduction divided by the study duration. For example, if the total percent cost reduction is 10% over a two-year period, then the average per annum cost reduction is 5%.

(6) **Short-term data extrapolation.** Extrapolate short-term study results for ten years using the long-term baseline study as the basis for per annum estimates. This provides an estimate of potential long-term savings using the DM interventions for each study.

4.4.1.2. Study Classification Based on Duration of Follow-up

Five studies reported post-intervention cost reductions. Four of these are considered short-term studies (i.e., less than three years in duration) and one is considered long-term. Table 10 identifies these studies.

Table 10: The lead author, title, and length of study duration for studies assessed in this section

Lead Author	Title	Follow-up Duration
Edward J. Bernacki	Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs	10 years
Bengt B. Arnetz	Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study	1 year
Marjorie L. Baldwin	Effects of provider networks on health care costs for workers with short-term disabilities	3 years
Allen Cheadle	Evaluation of the Washington State workers' compensation managed care pilot project II	1 year
Mark Lemstra	The effectiveness of standard care, early intervention, and occupational management in workers' compensation claims: part 2	1 year

4.4.1.3. Select a Long-Term Study to Serve as a "Baseline" Study

Only one long-term study was available. This study provides convincing evidence of the positive long-term impact of using DM interventions to treat WC injuries. (The publication assessed in this section is only one of about a half dozen publications during the past 10 years reporting on the disability management program at Johns Hopkins University initiated in 1992.) Key features of this study included:

- A well-defined set of interventions, why they were selected, and how they were used
- Extensive data on component effects for medical, indemnity, and administrative costs

- Data on payroll costs for each year of the intervention

For these reasons, the Johns Hopkins University DM program, and the results reported by Bernacki and Tsai in their 10-year follow-up, have been identified as the baseline study for comparative and exploratory long-term projections using short-term data.

4.4.1.4. Identify and Classify DM Interventions and Cost Reductions

Step 3 is reported in this section. Specifically, DM interventions for each study were identified and each intervention was rated based on how it was applied in that study as compared to the baseline study. For example, one of the DM interventions is treatment planning. Based on information from Bernacki and Tsai, individual treatment plans for workers at JHU were created by "a multidisciplinary medical management workgroup" consisting of nurse managers, physicians, therapists, and administrators, among others.[148] The Baldwin *et al*. study reported that "in some cases the network contract require[d] that providers cooperate with a medical management team and follow network protocols in treating injury workers."[149] Based on this information, the JHU study appears to have used treatment planning in a more comprehensive manner. As such, the use of treatment planning discussed in the Baldwin *et al*. study is deemed to be less rigorously applied than treatment planning in the baseline JHU study.

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[148] Bernacki EJ and Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.
[149] Baldwin ML, Johnson WG and Marcus SC. Effects of provider networks on health care costs for workers with short-term injuries. *Medical Care* 2002;40(8):686-695.

Total percent and per annum cost reductions are also identified. Information for each item is reported if data is available from the literature. Figure 7 identifies the DM interventions used in each study, assesses the degree to which the interventions were used, and provides percent cost reduction outcomes.

Figure 7: Types of DM interventions used for the assessed studies as well as percent cost reduction reported for each study

5 Studies Reviewed

		Bernacki (10 Year F/U)	Arnetz (1 Year F/U)	Baldwin (3 Year F/U)	Cheadle (1 Year F/U)	Lemstra (1) (1 Year F/U)
DM Intervention	Network / PPO	◉		◐	●	
	Occupational Med	◉		◐	◐	
	Physical Therapist	◉				◐
	Early Intervention		●			
	Guidelines	◉		◐	●	
	Treatment Planning	◉	●	◐	◐	
	Ergonomic Asses.	◉	●			◐
	Accommodation	◉	●			●
	Early RTW	◉			●	●
% Cost Reduction	Utilization Change	-	-	-23.7%	-	-
	Medical Change	-45.8%	-	-76.3%	-21.5%	-
	Indemnity Change	-63.3%	-	-	-45.3%	-
	Total Change	-54.2%	-21.4%*	-11.1%†	-32.3%	-41.3%
	Per Annum Change	-5.42%	-21.4%	-11.1%	-32.3%	-41.3%

◉ Index intervention ● Meets index intervention standards ◐ Does not meet index intervention standards

* This value does not include the cost of DM interventions.
† The proportion of total change accounted for by the utilization effect (i.e., utilization change) and the medical price effect (i.e., medical change).

4.4.1.5. Short-Term Data Extrapolation

To make informed decisions regarding changes to the Texas Workers' Compensation system, policymakers and stakeholders must have reliable short- and long-term data in which to assess these changes. In this review, four short- and one-long term studies have been identified and assessed. The short-term studies show per annum cost reductions ranging from 11.1% to 41.3% for up three years post-DM intervention implementation. However, these short-term results do not depict potential long-term cost reductions. Generally speaking, it is expected that cost reductions are typically greatest early during an intervention's life cycle with a gradual decrease over time.

To provide policymakers and stakeholders with more information regarding potential long-term savings using DM interventions, this section extrapolates findings from the short-term studies for up to ten-years using the long-term study as a baseline. Pros and cons of this approach are explained in Table 11. The method used to estimate long-term trends using short-term data is outlined below (also see Figure 8):

Table 11: Pros and cons of estimating long-term trends using short-term data

Pros	Cons
Extrapolating data from short-term studies provides additional evidence of potential cost reductions over time using a variety of DM interventions.	Because data extrapolation is based on a single long-term study, any idiosyncrasies in the long-term study will be reflected in the extrapolations (e.g., cost increases due to a high rate of unexpected injuries)
Extrapolating data from multiples sources shows that cost reductions vary by DM intervention and injury type (e.g., type of intervention, quantity of intervention, and the degree to which interventions are used)	Specific study criteria may provide long-term results that are not representative of cost reductions for the general population (e.g., if the long-term study concentrates on specific injuries, extrapolations may not be generalizable)
Extrapolation maximizes the use of limited data to identify potential long-term cost reductions rather than relying on a single long-term study.	Potential cost reductions can only truly be identified when actual long-term studies are carried out

ESTABLISHING THE BASELINE

(1) Select the baseline study (by Bernacki and Tsai) to provide long-term data in order to extrapolate short-term findings.

(2) Identify the baseline cost. In the Bernacki and Tsai study, it is $0.8092 per $100 of payroll.

(3) Using the baseline study, calculate absolute cost reduction between years (e.g., between years 1 and 2, years 2 and 3, etc.). For example, the absolute cost reduction between year 1 and 2 is $0.8092 - $0.7526 = $0.0565.

(4) Calculate the annual cost reductions as a percent of the baseline cost: (3) / (2) x (100) = X %. For example, the cost reduction between year 1 and year 2 was $0.0565. Thus, $0.0565 / $0.8092 (100) = 6.99%. The cost reduction between years 1 and 2 was 6.99% of the baseline cost. Continuing the example for the next period, the cost reduction between year 2 and year 3 was $0.0817; thus, $0.0817 / $0.8092 (100) = 10.10%. The cost reduction between years 2 and 3 was 10.10% of the baseline cost.

INDEXING THE SHORT-TERM STUDY

(5) Use the year 1 short-term per-annum unadjusted cost reduction of each respective study as the year 1 long-term per annum adjusted input value.

(6) Calculate the ratio of the adjusted cost reductions between period 1 (years 1 and 2) and period 2 (years 2 and 3) of the baseline study. Using proportion calculations, apply this ratio to the period 1 (one-year) percentage cost reduction observed in the short-term study to calculate the estimated percentage cost reduction that would be observed for period 2 in the short-term study. In the baseline study, a cost reduction equal to 6.99% of the baseline cost occurred between year 1 and year 2; a cost reduction equal to 10.10% of the baseline cost occurred between years 2 and 3. The short-term Arnetz *et al*. study reported a one-year cost reduction of 21.36%. It is then assumed that the one-year reduction of 21.36% (found in Arnetz *et al*., or in the first year of any of the four studies) is equivalent to the one-year reduction of 6.99% found in the baseline study. The projected period 2 cost reductions in the Arnetz *et al*. study will be proportional to the 10.10% cost reduction found in the baseline study. Calculating the proportion is as follows:

Period 1 Baseline / Period 2 Baseline = Period 1 Short-Term / Period 2 Short-Term

6.99% / 10.10% = 21.36% / X or

6.99% (X) = (10.10%) (21.36%) or

X = 215.74% / 6.99% or

X = 30.86%

Figure 8: Diagram of steps used to calculate long-term extrapolations

Establishing the Baseline

1. Identify baseline study

Bernacki EJ, Tsai SP. Ten years experience using an integrated workers' compensation management system to control workers' compensation costs. *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516. (Note: $ figures are per $100 in payroll)

2. Identify baseline cost in $

The baseline cost per $100 of payroll is $0.8092

3. Calculate p.a. savings in $

$0.8092 - $0.7526 = $0.0565

4. Calculate p.a. savings in %

$0.0589 / $0.8092 (100) = 7.28%

Fiscal Year		Dollar Savings Per $100 Payroll	Percent Savings Per $100 Payroll
1992			
1993	$	0.0565	6.99%
1994	$	0.0817	10.10%
1995	$	0.0678	8.38%
1996	$	0.0976	12.06%
1997	$	0.0443	5.47%
1998	$	0.0177	2.18%
1999	$	0.0589	7.28%
2000	$	(0.0020)	-0.25%
2001	$	(0.0394)	-4.87%
2002	$	0.0559	6.91%
Total	**$**	**0.4389**	**54.24%**

Short-Term Study Indexing

5. Identify year 1 savings in %

6. Calculate p.a. savings in %

P1b / P2b = P1st / P2 st
6.99% / 10.10% = 21.36% / X
215.74 / 6.99
X = 30.86

Year	Bernacki & Tsai Baseline	Arnetz *et al* .	Baldwin *et al* .	Cheadle *et al* .	Lemstra and Olszynski
Year 1	6.99%	21.36%	11.10%	32.30%	41.30%
Year 2	10.10%	30.86%	16.04%	46.67%	59.67%
Year 3	8.38%	25.62%	13.31%	38.74%	49.53%
Year 4	12.06%	36.86%	19.15%	55.73%	71.26%
Year 5	5.47%	16.72%	8.69%	25.28%	32.32%
Year 6	2.18%	6.67%	3.47%	10.09%	12.90%
Year 7	7.28%	22.25%	11.56%	33.65%	43.02%
Year 8	-0.25%	-0.77%	-0.40%	-1.17%	-1.49%
Year 9	-4.87%	-14.89%	-7.74%	-22.52%	-28.79%
Year 10	6.91%	21.11%	10.97%	31.92%	40.82%
Total	**54.24%**	**165.78%**	**86.15%**	**250.68%**	**320.53%**

Yellow shading denotes baseline percent savings per $100 of payroll.

Note: Cumulative short-term study indexing sums to greater than 100% based on indexing to the baseline

Calculations from step six in Figure 8 are used to calculate the 10-year trend line of long-term savings, which is then used in part two.

4.4.2. Part 2 – Costs Associated with Implementing DM Interventions

DM programs encounter initial and on-going costs, some of which are specific to the DM intervention, while others are related to larger system changes (e.g., networks). This section identifies cost drivers related to establishing a DM network and their estimated expense (see Table 12).

Table 12: Costs for establishing a disability management program in Texas

Cost Driver	Included Services	Estimated Expense*
Network development	• Provider application • Credentialing • Due diligence review • Contracting with provider • Transactional costs	• $1,000 per provider[150] • The expected number of providers ranges from 3,000 to 4,000 for the state of Texas[151] • Initial cost (for network establishment): $3 - $4 million • Ongoing annual cost (for an established network): Estimated at 50% of the original cost for renewing providers; new providers are expected to still cost $1,000 each. Total estimate of $3 - $4 million.
Treatment planning	• DM services (beyond original physician services) for injuries that do not heal within 30 days after injury • 2 – 3 visits to a disability management doctor (DMD) • Administrative / processing costs between the network and DMD • Care management services	• 2 – 3 DMD visits: $750 total • Administrative processing: $250 • Care management: $500 • Initial cost (for the first 3 visits to the DMD): $1,500 per patient requiring the use of DM services • Ongoing cost (per additional DMD visit): $300 per patient visit
Employer	• Job assessment / accommodation • Job modification / temporary reassignment	• Costs are included under care management • Job modification / temporary reassignment costs will vary by industry and position
DM Guidelines	• Treatment guidelines • Lost time guidelines	• $500 to $1,000 per license (i.e., per provider) dependent on the ability of networks or the state to negotiate volume discounts for using a particular set of treatment / lost time guidelines • Initial cost: $2 - $4 million • Ongoing cost (for license renewal): This amount is likely to be similar to the initial cost, but may not occur on an annual basis (e.g., biannually)
Other	• Dispute resolution	• $1,000 for each worker requiring dispute resolution services. It is estimated that 10% of workers will use this service.

* Unless otherwise specified, cost estimates were provided in consultation with TWCC.

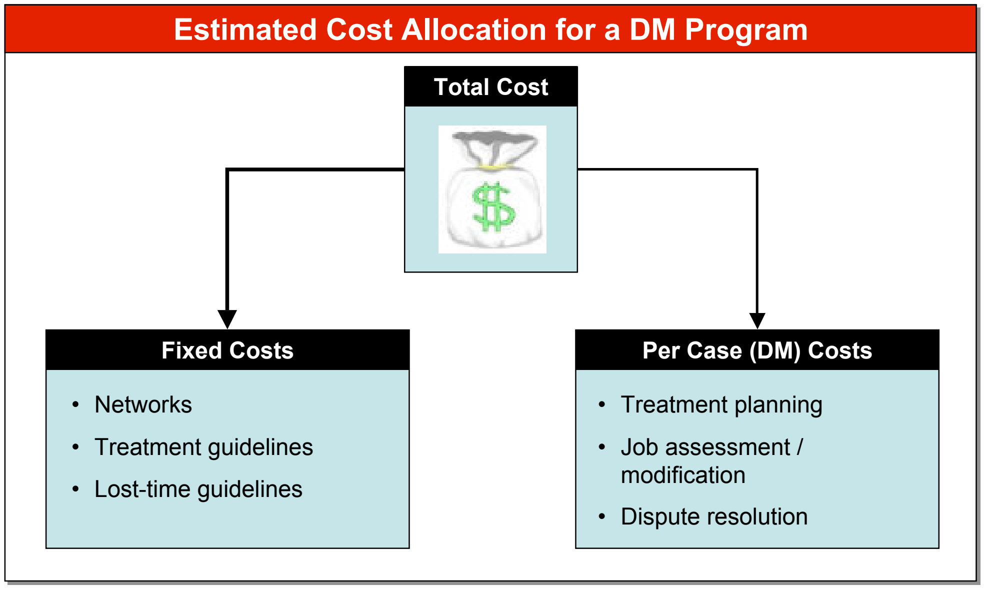
[150] Final report on the feasibility of regional workers' compensation networks operating in the state of Texas. MedFx, LLC. Mill Valley, CA February 2003: 1-69.
[151] *Ibid.*

4.4.2.1. Per Annum DM Intervention Costs

Costs for DM interventions will vary over time. There are initial and on-going costs to consider as well as fixed and case-specific costs to consider. Each contributes to the overall cost in a different way (see Figure 9).

- **Initial costs:** These costs are associated with establishing DM interventions. For example, the cost of *establishing* a network is estimated to be $1,000 per provider.
- **On-going costs:** These costs are associated with maintaining DM interventions that are already in place. For example, the cost of *maintaining* a network with a DM component is less costly than establishing it. Generally speaking, maintaining a network should cost about half the initial costs, or about $500 per provider per annum.
- **Fixed costs:** These costs occur on a per annum basis, regardless of whether a patient uses DM services. For example, the cost of running a network (whether it is an initial cost or an on-going cost) is a fixed cost. These costs are due to setting up the infrastructure to provide DM services. The majority of patients (70%) will not require a DM intervention, but they will use the network for WC care. Another example of a fixed cost within the DM paradigm is the cost of purchasing treatment and time-loss guidelines.
- **Case-specific costs:** These are costs associated with DM activities. In particular, these are costs that carriers will incur for patients who require treatment by a disability management doctor (DMD), treatment planning, and care management. Another type of specific cost includes dispute resolution.

Figure 9: Allocation of costs associated with a DM program



4.4.3. Part 3 – Calculating Long-Term Cost Estimates Using TWCC Data

This section uses long-term projections calculated in part 1 as a basis to calculate savings using TWCC data for specific injury categories and specific DM interventions. For example, if projections in part 1 indicated a 20% cost reduction in year one after implementing a certain set of interventions for back cases, a similar calculation will be prepared using TWCC claimants with those same injuries and (assumed) same interventions. Therefore, the estimated savings using TWCC data will be based on characteristics identified in the short-term studies, which are described below. Long-term cost savings for each model are detailed in Appendix C.

4.4.3.1. Short-Term Data Sources

Four studies from the peer-reviewed literature were used as data sources for this model.

(1) **Effect of provider networks on short-term injuries (Baldwin *et al.*):**[152] This study reviewed the impact of network management on short-term medical claims for five injury groups: (1) back pain; (2) non-back sprains, strains, and dislocations; (3) inflammations, lacerations, and contusions; (4) fractures; and (5) cumulative stress injuries. Because this study focused on short-term claims, *estimated savings calculated based on this study are for medical costs only.*

[152] Baldwin ML, Johnson WG and Marcus SC. Effects of provider networks on health care costs for workers with short-term injuries. *Medical Care* 2002;40(8):686-695.

(2) Effect of early workplace intervention for employees with musculoskeletal-related injuries (Arnetz *et al.*):[153] This study reviewed the impact of early intervention (EI) for injured workers. EI activities in this study involved using common DM techniques (e.g., treatment planning, ergonomic assessment) early in the course of treatment. The EI activities in this article were "early" in the sense that proactive care was sought immediately after injury.

(3) Effect of a managed care program versus fee-for-service (Cheadle *et al.*):[154] This study reviewed the impact of a managed care pilot program using experience rated capitation, occupational medicine physicians, treatment guidelines, and treatment planning. Worker and injury characteristic comparisons (e.g., age, gender, marital status, number of dependents, monthly wage, injury type) were similar between the managed care (MC) and fee for service (FFS) groups; none of the differences were statistically significant. All injury groups were assessed.

(4) Effect of occupational management versus standard care (Lemstra and Olszynski):[155] A study by Lemstra and Olszynski compared occupational management to standard care for upper-extremity disorders and back pain. (These authors also assessed the impact of extensive early rehabilitation and work hardening, but these results show negative results compared to both standard care

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[153] Arnetz BB, Sjögren B, Rydèhn B and Meisel R. Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study. *Journal of Occupational and Environmental Medicine* 2003;45(5):499-506.
[154] Cheadle A, Wickizer TM, Franklin G, *et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project 2: medical and disability costs. *Medical Care* 1999;37(10):982-993.
[155] Lemstra M and Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in Workers' Compensation claims: part 2. *Spine* 2004;29(14):1573-1579.

and occupational management and are not analyzed here.) An earlier study by Lemstra and Olszynski also reviewed the impact of occupational care vs. standard care for upper-extremity disorders and back pain.[156] However, this study was not included in this section because the first year savings were extremely high at 76.7%. This caused technical problems with the cost estimations in that linear trend calculations for year one approached 110%, a figure that is not possible, nor reasonable, to emulate in Texas.

4.4.3.2. Data Aggregation

The injury groups assessed in each study were used as the basis to calculate estimated savings within the TWCC population. Three of these studies assessed specific injury groups, while one study assessed all injuries for the study population. To make proper comparisons between the peer-reviewed studies and the TWCC population, it is necessary that the injury group(s) in the TWCC population match (as closely as possible) the population in the respective comparison study. For example, if a study assessed the impact of DM interventions on the costs associated with musculoskeletal disorders (MSD), then the comparison calculations for the TWCC population will also only assess MSDs.

In order to match injuries in the TWCC population with injuries in the comparison population the authors of each study were contacted to determine how they classified

[156] Lemstra M and Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in workers' compensation claims. *Spine* 2003;28(3):299-304.

injuries. Specifically, the authors were asked if they used ICD-9 codes as a basis for classifying injuries, and if not, what was used as the basis for classifying injuries. Table 13 reports how the original study classified injuries and how injuries were subsequently classified for this report.

Table 13: Method of categorizing claims

Lead Author	Original Claim Categorization Method	TWCC Claim Categorization Method
Bengt B. Arnetz (Contacted and provided feedback)	• Target injury group: Musculoskeletal disorders (MSD) • Claim categorization: Used the diagnostic classification listed on the sick leave certification from the National Social Insurance Office • All MSDs related to the neck, shoulder, back, and joint, were included • Symptom severity was determined by questionnaire • ICD-9 codes were not used	• Target injury group: Musculoskeletal disorders • Body location: neck, shoulder, thoracic spine, lumbar spine, and joints were included • MSD injury type: soft tissue injury, superficial trauma, skeletal trauma, and degenerative disease • Claim categorization: MSDs were identified based on diagnostic categories identifying the body location and injury type (see Table 66)
Marjorie L. Baldwin* (Contacted and provided feedback)	• Target injury group: back pain; non-back sprains, strains, and dislocations (SSD); inflammations, lacerations, and contusions (ILC); fractures, and cumulative stress injuries. • Claim categorization: ICD-9 codes	• Target injury group: back pain; non-back sprains, strains, and dislocations (SSD); inflammations, lacerations, and contusions (ILC); fractures, and cumulative stress injuries • Claim categorization: Injury groups were identified based on diagnostic categories identifying the body location and injury type (see Table 64)
Allen Cheadle (Did not need to contact since all claims were included)	• All claims were included	• All claims were included
Mark Lemstra * (Contacted and received no feedback)	• Target injury group: Work-related upper extremity musculoskeletal (WRUEM) disorders and back pain • Claim categorization: ICD-9 codes	• Target injury group: WRUEM disorders and back pain • Claim categorization: Injury groups were identified based on diagnostic categories identifying the body location and injury type (see Table 69)

* The corresponding author for this study was contacted, not the lead study author.

4.4.3.3. Inclusion Criteria

All medical and indemnity costs for each claim are included in the TWCC population for analysis based on the following inclusion criteria:

- Injury groups in the TWCC population analysis match the injury group population in the comparison study.
- Only TWCC claims between 30 days and two years in length are included in the analyses. This is because these claims are the most likely to benefit from DM interventions. Claims less than 30 days in length have resolved and do not require additional treatment. Claims greater than 2 years typically have other prognostic or diagnostic factors that render them more complex and not likely to respond to typical DM interventions. The only exception to this criterion is the Baldwin *et al*. comparator analysis in which only claims less than seven days were assessed.

4.4.3.4. Assumptions

The following assumptions were made when calculating cost savings:

- Individual analyses are conducted for each of the four study populations using TWCC data as the comparator.
- Analyses are conducted using injuries in the TWCC population matched to injuries used in the original study population.
- The TWCC population is also matched to the study population on the medical service expenditure outcome assessed in the original study (e.g., if the study only assessed the medical cost outcome, the corresponding TWCC population will only assess medical cost outcomes).

- The number of TWCC patients presenting with an injury is expected to remain steady throughout the estimation period (i.e., the same number of injuries for a particular body system occur in year 10 as in year one).
- DM interventions responsible for cost savings in the original study are assumed to be the same interventions that would be responsible for potential cost savings in the TWCC analysis.
- Cost reductions in the original study are assumed to occur in the TWCC population, despite some of the unique characteristics of the Texas workers' compensation system (e.g., the voluntary nature of the Texas system).
- Cost savings in the baseline study by Bernacki and Tsai are assumed to hold true for cost savings calculated in this section.
- Fixed costs for implementing DM activities (e.g., network creation and maintenance) are shared across all workers, regardless whether they have an injury or not.
- Medical inflation is projected to be 5.757% per annum over the next 10 years based on average medical inflation data from 1984 through 2003 from the United States Bureau of Labor and Statistics.

4.4.3.5. Method for Calculating Projected Cost Savings

Cost savings due to DM interventions were estimated for ten years using linear trend data and DM implementation cost information discussed above. Calculations were conducted on MS Excel. Calculations were made on a cost per claim basis. A sensitivity analysis was conducted based on three initial penetrations rates for the availability /

implementation of DM in Texas with subsequent increased penetration during the first five years after DM is implemented. The three first year estimates are 20%, 30%, and 40%. For each of these estimates, the second year penetration is assumed to increase by 10% and year 3 – 5 estimates are expected to increase by an additional 5% each. Therefore, at year 5, the three penetration estimates will be 45%, 55%, and 65%; these penetration rates are assumed to remain at these values for years 6 - 10. The estimates were calculated as follows:

COST PER CASE CALCULATIONS:

Cost per case calculations were estimated for two case types: (1) those that use treatment planning; and (2) those that do not (usual care). Table 14 provides details of the types of costs associated with each case type.

Table 14: Costs associated with DM to include treatment planning and usual care

Cost Type	DM to Include Treatment Planning Group	Usual Care Group
TWCC cost per case	This is the current TWCC cost per case for this injury type. Savings calculations are based on this baseline value.	This is the current TWCC cost per case for this injury type. Savings calculations are based on this baseline value.
Fixed costs per case	Costs associated with network management and administrative costs. All claimants, regardless of whether they have treatment planning, will incur these costs.	Costs associated with network management, dispute resolution, or other administrative costs. All claimants, regardless of whether they have treatment planning, will incur these costs.
Cost per treatment planning	Costs associated with providing DM interventions (e.g., care management, referral to a occupational physician). Only patients using treatment planning incur these costs.	Not applicable to this group.
Dispute resolution	Costs associated with a dispute related to treatment. A subset of the total population (which is estimated at 10%) will incur this cost. This cost is expected to be evenly distributed between both the treatment planning group and the usual care group.	Costs associated with a dispute related to treatment. A subset of the total population (which is estimated at 10%) will incur this cost. This cost is expected to be evenly distributed between both the treatment planning group and the usual care group.

The net cost per case for the DM to include treatment planning group is calculated as follows:

Net Cost Per Case for DM to Include Treatment Planning Group = Fixed Costs + Treatment Planning Costs + Dispute Resolution Costs – Savings Due to the Intervention

The net cost per case for the usual care group is calculated as follows:

Net Cost Per Case for Usual Care Group = Fixed Costs + Dispute Resolution Costs

In order to calculate the relative impact of DM on overall savings, the cost per case for the treatment planning group is multiplied by the respective sensitivity analysis value. For example, if the sensitivity analysis assumes 30% penetration for the DM / treatment planning group, only 30% of the total cases analyzed will represent the net cost of this group; the remaining 70% of cases will represent the net cost of the usual care group. For example, if we assume a 30% penetration rate for DM in the treatment planning group:

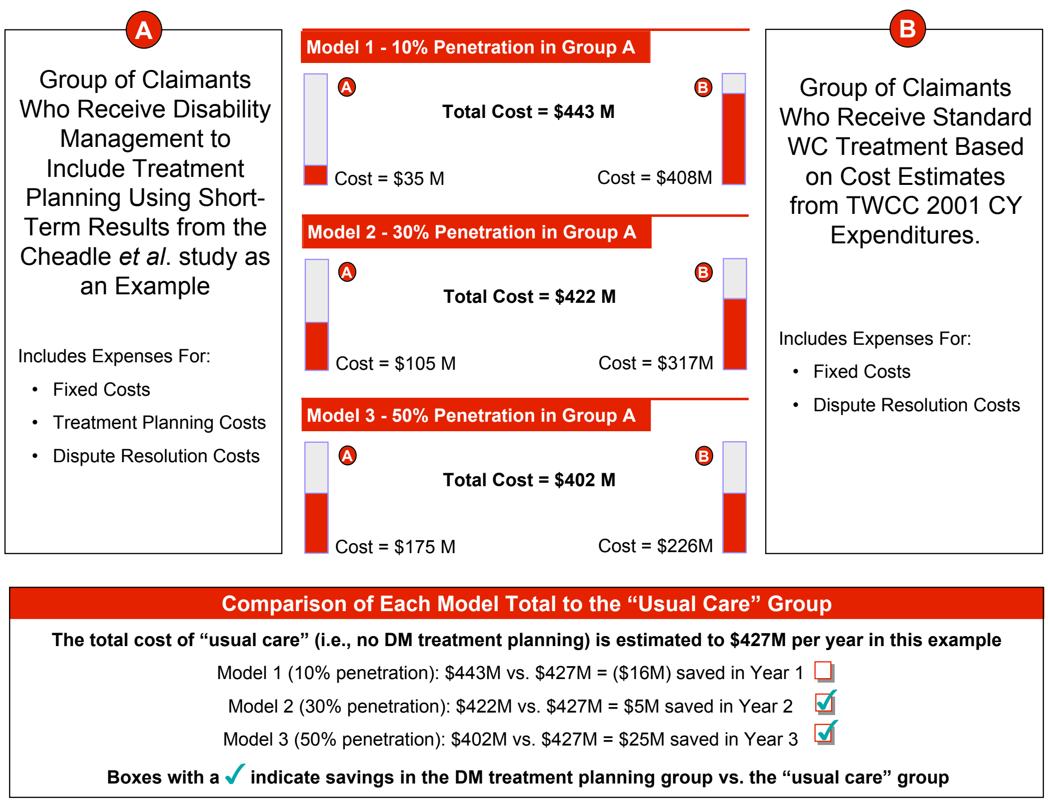
Total DM to Include Treatment Planning Cost = (Net Cost Per Case for Treatment Planning) x (0.30 * Total Population Being Treated)

The corresponding total usual care cost is:

Usual Care Treatment Cost = (Net Cost Per Case for Usual Care Group) x (0.70 * Total Population Being Treated)

The sum of the *total DM to include treatment planning cost* and the *usual care treatment cost* represents the total treatment cost for that penetration rate (30% in the example above). This total is then compared to the total treatment cost without any intervention whatsoever (i.e., the cost of 100% of the patients as if they had no intervention whatsoever). It is this comparison that determines the amount saved, if any (see Figure 10).

Figure 10: The method used to calculate projected cost savings for DM interventions to include treatment planning based on TWCC data and long-term projections



5. Results

The results section is sub-divided into four main parts: (1) general descriptive results; (2) bivariate results; (3) regression results; and (4) results of the cost estimation model.

5.1. Descriptive Results

The Texas Workers' Compensation Commission provided primary data for this study. Information is reported for all claims that occurred during the study period. Three types of expenditure information are reported in this study: (1) medical payment; (2) lost time; and (3) medical payment and lost time combined. Table 15 provides a brief summary of descriptive information for key variables.

Table 15: Descriptive information for key variables

Variable	N	Mean	Median	Min	Max	S.D.
Claim	331,339	-	-	-	-	-
Claimant	163,773	-	-	-	-	-
Pre-injury weekly wage	77,090	$527.40	$452.91	$25	$81,520.00	$470.28
Medical service payment	280,770	$3,642.80	$448.74	$0	$1,149,149.70	$11,814.38
Lost time benefit	83,446	$6,450.04	$2,741.14	$0	$168,750.00	$9,629.73
Total expenditure*	293,361	$5,321.15	$512.00	$0	$1,225,204.60	$15,230.21
Number of benefit weeks	83,382	18.67	8.00	0	148	25.83
Age (years)	163,773	39.12	39.00	14	85	11.80

Note: Variable information is subject to the exclusion criteria outlined in the methods section
* Total expenditure is the sum of medical service payment and lost time benefit payment; however, these values do not necessarily sum as expected because not all claimants with a medical claim have a benefit claim.

5.1.1. Claimant and Claim Variables

Each injured worker is assigned a unique claimant identification number. This number identifies the claimant and his or her supporting personal information. In addition, each time a worker reports an injury, that injury is assigned a unique claim identification number that tracks benefits and costs associated with that particular injury. If a worker is injured more than once, this worker will use the same claimant identification number but will have multiple claim numbers – one for each injury episode.

5.1.2. Age

Claimants were, on average, 39.12 years old (S.D. = 11.80). To protect patient confidentiality, only the claimants' year of birth was reported. Each claimant was assigned a birthday of July 1 (the mid-point) of the year of his or her birth to minimize bias in estimating the claimant's age. Age at the time of injury was calculated as the difference between the date the injury claim was filed and the individual's date of birth (i.e., July 1, 19XX).

5.1.3. Pre-Injury Weekly Wage

A total of 77,090 claimants had a pre-injury weekly wage reported. This wage, as provided by the claimant and verified by the carrier, is the basis for establishing lost time benefits, most noticeably temporary income benefits (TIB). The mean pre-injury weekly wage was $527.40 (S.D. = $470.28).

5.1.4. Payment

Provider payments (rather than provider charges) were used to represent costs associated with medical care. The rationale is that the payment amount is a better reflection of the true cost of medical care and it has been previously used by other researchers for cost analyses related to WC.[157,158,159,160]

All claims that have at least one service utilization or medical treatment have a payment associated with that claim. For example, a claimant who visits a physician for evaluation of a hand laceration may have a payment amount for the consultation, radiographs, and equipment use. Claimants with more severe injuries may require extensive use of hospitalization and thus may have more individual billings (and higher costs) associated with that injury. The average payment for medical care was $3,642.80 (S.D. = $11,814.38). This large standard deviation was expected with payment data because of the expensive nature of treating some workplace injuries (e.g., hospitalization and surgery due to multiple injuries).

5.1.5. Lost Time Benefit

A total of 83,446 claimants received a lost time benefit with an average total payout of $6,450.04 (S.D. = $9,629.73). Only claimants who are off work greater than seven days receive a temporary lost time benefit and this benefit stops after they return to work, reach maximum medical improvement, or exhaust their benefit as determined by current

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[157] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation physician claims *American Journal of Industrial Medicine* 1997;32(1):27-34.
[158] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation hospitalized claims. American Journal of Industrial Medicine 1999;35(2):103-111.
[159] Baldwin ML, Johnson WG and Marcus SC. Effects of provider networks on health care costs for workers with short-term injuries. *Medical Care* 2002;40(8):686-695.
[160] Cheadle A, Wickizer TM, Franklin G*, et al.* Evaluation of the Washington State Workers' Compensation Managed Care Pilot Project 2: medical and disability costs. *Medical Care* 1999;37(10):982-993.

TWCC rules and regulations. After temporary income benefits end, other forms of lost time payment may begin, depending on the claimant's particular circumstances.

5.1.6. Total Payment

Total payment is the sum of all medical and lost time dollars spent on behalf of a particular claim. The average total payment of $5,321.15 (S.D. = $15,230.21) is based primarily on medical payments.

5.1.7. Diagnostic Categories

As noted in the methods section, diagnostic categories link specific diagnoses codes of similar body part and problem type together. The 10 most common diagnostic categories by number of claims and their associated medical payments are listed in Table 16 below. Data for this table come from medical information provided by the carrier. It should be noted, however, that the carrier reports claims data periodically; therefore, totals reflected in Table 3 do not yet reflect the total number of claims reported in Table 16.

Table 16: Top 10 diagnostic categories by frequency of injury and associated mean medical payment per diagnostic code for calendar year 2001.

Group	Description	N	% of Total Injuries	Mean Medical Payment Per Group	% of Total Medical Expenditure	Total Medical Expenditure per Group
502	Low back strain / sprain	26,807	10.6%	$ 4,984.38	13.06%	$ 133,616,189.21
808	Hand / wrist laceration	20,796	8.2%	$ 1,058.35	2.15%	$ 22,009,399.29
501	Low back regional pain	10,685	4.2%	$ 5,772.33	6.03%	$ 61,677,328.39
602	Shoulder strain / sprain	9,265	3.7%	$ 5,083.38	4.60%	$ 47,097,519.75
1102	Ankle, foot strain / sprain	8,693	3.4%	$ 1,864.74	1.58%	$ 16,210,217.48
302	Neck strain / sprain	8,272	3.3%	$ 5,898.99	4.77%	$ 48,796,440.70
802	Hand / wrist strain / sprain	8,061	3.2%	$ 2,930.13	2.31%	$ 23,619,774.88
807	Hand / wrist abrasion / contusion	7,534	3.0%	$ 1,159.01	0.85%	$ 8,731,963.85
1004	Knee / tendon ligament rupture	5,592	2.2%	$ 4,951.52	2.71%	$ 27,688,911.37
810	Hand / wrist fracture	5,433	2.1%	$ 4,043.41	2.15%	$ 21,967,861.57

5.1.8. Medical Service Utilization

Four types of medical service utilization are measured in this study: (1) visits to the physician's office; (2) hospital visits; (3) emergency department visits; and (4) visits to other practitioners (e.g., physical therapist, etc.). As noted in Table 8, these visits are determined based on CPT-4 code billing. Table 17 provides a descriptive summary of medical service utilization (MSU) variables across all claims that had at least one type of medical service utilization. Table 18 provides utilization information for people who had a payment for that particular type of service (e.g., the mean number of hospitalizations for those with a hospital visit was 2.37 ± 3.03).

Table 17: Descriptive statistics for medical service utilization for all claimants at the system level

MSU Type	N	Min	Max	Mean	S.D.
Number of office visits	280,770	0	504	8.15	20.14
Number of hospitalizations	280,770	0	102	0.91	2.20
Number of emergency department visits	280,770	0	39	0.22	0.57
Number of visits "elsewhere"	280,770	0	3,288	39.03	104.17

Table 18: Descriptive statistics for medical service utilization for all claimants at the user level

MSU Type	N	Min	Max	Mean	S.D.
Number of office visits	221,901	1	504	10.31	22.15
Number of hospitalizations	107,658	1	102	2.37	3.03
Number of emergency department visits	52,501	1	39	1.21	0.77
Number of visits "elsewhere"	265,191	1	3,288	41.32	106.74

5.1.9. TWCC Service Region

The TWCC Region in which medical service was provided is based on the zip code of the primary healthcare provider. Zip codes were matched by county to zip-code tabulation data provided by the Texas Data Center at the University of Texas at San Antonio. TWCC regions were matched by coding each county to the local TWCC field office and each field office was matched to the appropriate TWCC region. In total, there are four TWCC regions.

5.2. Bivariate Results

This section presents results that assess relationships between selected variables. In particular it outlines (1) the different relationships tested; (2) rationale for conducting bivariate analyses; (3) the specific statistical tests used; and (4) a discussion of the results and the value of this information to TWCC.

5.2.1. Hypothesis 1 – Age and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if relationships existed between age and: (a) medical service utilization; (b) expenditure; and (c) lost time. Table 19 provides details of the eight outcome variables analyzed, descriptive information, and results from the statistical tests.

Table 19: Pearson correlation results: outcome variables assessing medical service utilization, expenditure, and time off work with age

	Variable Name	N	Mean (S.D.)	Mean $	Correlation	Significance
IV	Age	163,773	39.12 (11.80)	-	-	-
MSU	No. of office visits	280,770	8.15 (20.14)	-	0.04	p < 0.001
	No. of hospital visits	280,770	0.91 (2.20)	-	0.07	p < 0.001
	No. of ED visits	280,770	0.22 (0.57)	-	-0.04	p < 0.001
	No. of visits elsewhere	280,770	39.03 (104.17)	-	0.05	p < 0.001
Expenditure	Log of medical payments	280,770	6.39 (1.92)	$3,642.80	0.11	p < 0.001
	Log of lost time benefits	83,446	7.74 (1.63)	$6,450.04	0.11	p < 0.001
	Log of total expenditure	293,361	6.60 (2.05)	$5,321.15	0.12	p < 0.001
TO	No. of weeks off work	83,382	18.67 (25.83)	-	0.06	p < 0.001

IV = The independent variable for this hypothesis
MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
TO = Time off from work based on number of weeks lost time benefits were received
Note: Mean dollar values are for descriptive purposes only; statistical tests were conducted using log values

Statistical Results: Results showed statistically significant relationships at the pre-determined alpha level of p = 0.001 between age and all eight outcome variables.

Despite attaining statistical significance, the correlation coefficients between age and outcome variables are weak (range: -0.04 – 0.12), thus indicating little variation in medical service utilization, expenditure, or time off accounted for by age. All of the correlation coefficients are positive except for the relationship between age and emergency department visits (-0.04). A positive correlation coefficient indicates that as age increases, the value of the other variable tends to increase. The negative correlation coefficient for number of ED visits indicates that as age increases, the number of ED visits tends to decrease. Table 20 provides an outcome summary for analyses associated with hypothesis 1.

Table 20: Outcome summary for analyses associated with hypothesis 1

#	Hypothesis	Rejected?	Direction
	There is no relationship between claimant age and the …		
1.1	… number of office visits	Yes	Positive
1.2	… number of hospital visits	Yes	Positive
1.3	… number of emergency department visits	Yes	Negative
1.4	… number of visits elsewhere	Yes	Positive
1.5	… log of medical payments	Yes	Positive
1.6	… log of lost time benefits	Yes	Positive
1.7	… log of total expenditure	Yes	Positive
1.8	… number of weeks off work due to injury	Yes	Positive

5.2.2. Hypothesis 2 – Gender and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if relationships existed between gender and: (a) medical service utilization; (b) expenditure; and (c) lost time. Table 21 provides details of the eight outcome variables analyzed, descriptive information, and results from the statistical tests.

Table 21: T-test results: outcome variables assessing medical service utilization, expenditure, and time off work by gender

	Variable Name	Gender	N*	Mean (SD)	Mean $	T-Value	Significance
MSU	No. of office visits	Male	71,245	14.53 (± 27.71)	-	-17.54	p < 0.001
		Female	41,073	17.70 (± 29.96)	-		
	No. of hospital visits	Male	71,245	1.58 (± 3.19)	-	4.96	p < 0.001
		Female	41,073	1.49 (± 2.91)	-		
	No. of ED visits	Male	71,245	0.28 (± .73)	-	12.30	p < 0.001
		Female	41,073	0.23 (± .61)	-		
	No. of visits elsewhere	Male	71,245	74.61 (± 146.98)	-	-11.80	p < 0.001
		Female	41,073	85.50 (± 150.08)	-		
Expenditure	Log of medical payments	Male	71,245	7.41 (±1.89)	$7,834.69	-5.37	p < 0.001
		Female	41,073	7.48 (±1.86)	$7,320.13		
	Log of lost time benefits	Male	53,123	7.78 (±1.63)	$6,785.56	10.06	p < 0.001
		Female	29,913	7.67 (±1.62)	$5,853.20		
	Log of total expenditure	Male	79,506	7.83 (±2.11)	$11,554.50	0.81	p = 0.003
		Female	45,352	7.83 (±2.09)	$10,490.09		
TO	No. of weeks off work	Male	53,079	17.91 (±25.35)	-	-11.07	p < 0.001
		Female	29,892	20.01 (±26.60)	-		

* The number of females plus males is less than the total number of claimants, because gender data is reported only on XX% of claimants
MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
TO = Time off from work based on number of weeks lost time benefits were received
Note: Mean dollar values are for descriptive purposes only; statistical tests were conducted using log values

Statistical Results: Seven of eight outcome variables analyzed showed statistically significant differences at p < 0.001. Only one variable, "log of total expenditure," was *not* statistically significant (p = 0.003). For medical service utilization, women tended have more office visits (17.70 vs. 14.53) and number of visits elsewhere (85.50 vs. 74.61) than men. For expenditure, women had a slightly higher mean log medical payment than men but slightly lower log payment for lost time benefits. For time off work due to injury, women tended to be off work longer than men (20.01 vs. 17.91 weeks). Table 22 provides an outcome summary for analyses associated with hypothesis 2.

Table 22: Outcome summary for analyses associated with hypothesis 2

#	Hypothesis	Rejected?	Direction
	There is no relationship between claimant gender and the …		
2.1	… number of office visits	Yes	Female > Male
2.2	… number of hospital visits	Yes	Male > Female
2.3	… number of emergency department visits	Yes	Male > Female
2.4	… number of visits elsewhere	Yes	Female > Male
2.5	… log of medical payments	Yes	Female > Male
2.6	… log of lost time benefits	Yes	Male > Female
2.7	… log of total expenditure	No	Male = Female
2.8	… number of weeks off work due to injury	Yes	Female > Male

5.2.3. Hypothesis 3 – Race and Outcome Variables

Data for the independent variable was incomplete. In particular, race was only reported for about 40% of all claimants. Because of the lack of data for this variable, analyses related to hypothesis 3 were not conducted.

5.2.4. Hypothesis 4 – Injury Type and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if differences existed among the top five claimant injury types as classified by "diagnostic category" with regard to: (a) medical service utilization; (b) expenditure; and (c) lost time. Details of the top five injury types reported to TWCC are described in Table 11. The one-way analysis of variance test was used to compare mean values across each of the five diagnostic categories for each dependent variable. Table 23 provides inferential results for hypothesis 4.

Table 23: One-way ANOVA results: outcome variables assessing medical service utilization, expenditure, and time off work by diagnostic category

	Variable Name	Group	df	Mean Sq.	F	Significance
MSU	No. of office visits	Between	4	443357.93	1046.62	$p < 0.001$
		Within	76,241	423.61		
		Total	76,245			
	No. of hospital visits	Between	4	1173.71	266.48	$p < 0.001$
		Within	76,241	4.41		
		Total	76,245			
	No. of ED visits	Between	4	155.10	426.55	$p < 0.001$
		Within	76,241	0.36		
		Total	76,245			
	No. of visits elsewhere	Between	4	9183489.34	858.01	$p < 0.001$
		Within	76,241	10703.22		
		Total	76,245			
Expenditure	Log of medical payments	Between	4	4578.50	1484.99	$p < 0.001$
		Within	76,241	3.08		
		Total	76,245			
	Log of lost time benefits	Between	4	491.83	183.25	$p < 0.001$
		Within	19,245	2.68		
		Total	19,249			
	Log of total expenditure	Between	4	6126.18	1742.46	$p < 0.001$
		Within	76,241	3.52		
		Total	76,245			
TO	No. of weeks off work	Between	4	113591.45	155.84	$p < 0.001$
		Within	19,232	728.88		
		Total	19,236			

MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
TO = Time off from work based on number of weeks lost time benefits received

Statistical Results: The omnibus F-test was statistically significant for all outcome variables by claimant injury type. This means that for each outcome variable (e.g., number of office visits, medical expenditure, weeks off work) there was at least one statistically significant result between the five injury diagnosis codes. Post-hoc tests examined the specific differences between claimant injury type for each independent variable. For example, for the dependent variable "number of office visits" there was a statistically significant difference in the number of office visits between patients who had diagnostic code 502 and 808, 502 and 602, and 502 and 1102.

Most, but not all, of the post-hoc comparisons were statistically significant. When making judgments on post-hoc comparisons, it is important to consider the injury type. Outcomes would be expected to differ by injury type since different injuries require different levels of care and attention. For example, it is reasonable to expect that a back injury would require more medical service utilization and have a higher medical expenditure than a wrist laceration. Yet, in terms of frequency of occurrence, both are included as top 5 injuries in this study, and it is the top five diagnostic categories that were selected for review. Table 24 provides an outcome summary for analyses associated with hypothesis 4 and Table 25 provides a summary of post-hoc test results.

Table 24: Outcome summary for analyses associated with hypothesis 4

#	Hypothesis	Rejected?
	There is no relationship between injury types and the …	
4.1	… number of office visits	Yes
4.2	… number of hospital visits	Yes
4.3	… number of emergency department visits	Yes
4.4	… number of visits elsewhere	Yes
4.5	… log of medical payments	Yes
4.6	… log of lost time benefits	Yes
4.7	… log of total expenditure	Yes
4.8	… number of weeks off work due to injury	Yes

Table 25: Post-hoc test results for outcome variables assessing medical service utilization, expenditure, and time off work by diagnostic category

	Variable Name	Diagnostic Code	N	Mean	SD	Significant Group Differences*				
						1	2	3	4	5
MSU	No. of office visits	1. 502	26807	13.50	26.28		*		*	*
		2. 808	20796	2.22	6.38	*		*	*	*
		3. 501	10685	12.62	24.13		*			*
		4. 602	9265	11.50	22.98	*	*			*
		5. 1102	8693	5.99	14.53	*	*	*	*	
	No. of hospital visits	1. 502	26807	.79	2.20		*	*		*
		2. 808	20796	.63	1.486	*		*	*	
		3. 501	10685	1.37	2.97	*	*		*	*
		4. 602	9265	0.88	2.07		*	*		*
		5. 1102	8693	0.53	1.75	*		*	*	
	No. of ED visits	1. 502	26807	0.15	0.55		*	*		*
		2. 808	20796	0.36	0.61	*		*	*	*
		3. 501	10685	0.25	0.90	*	*		*	
		4. 602	9265	0.12	0.40		*	*		*
		5. 1102	8693	0.21	0.48	*	*		*	
	No. of visits elsewhere	1. 502	26807	59.96	126.65		*			*
		2. 808	20796	11.42	40.14	*		*	*	*
		3. 501	10685	57.49	121.92		*			*
		4. 602	9265	62.36	126.52		*			*
		5. 1102	8693	25.83	72.33	*	*	*	*	
Expenditure	Log of medical payments	1. 502	26807	6.82	1.91		*		*	*
		2. 808	20796	5.77	1.33	*		*	*	*
		3. 501	10685	6.89	2.07		*			*
		4. 602	9265	6.98	1.93	*	*			*
		5. 1102	8693	6.18	1.53	*	*	*	*	
	Log of lost time benefits	1. 502	8430	7.86	1.69		*		*	*
		2. 808	1872	7.08	1.49	*		*	*	
		3. 501	4043	8.00	1.69		*		*	
		4. 602	3053	8.05	1.52	*	*			*
		5. 1102	1852	7.22	1.60	*		*	*	
	Log of total expenditure	1. 502	26807	7.03	2.036		*	*	*	*
		2. 808	20796	5.83	1.40	*		*	*	*
		3. 501	10685	7.18	2.22	*	*			*
		4. 602	9265	7.19	2.08	*	*			*
		5. 1102	8693	6.34	1.65	*	*	*	*	
TO	No. of weeks off work	1. 502	8423	22.22	28.81		*			*
		2. 808	1869	9.03	15.30	*		*	*	
		3. 501	4040	24.39	30.45		*		*	*
		4. 602	3053	21.57	25.99		*	*		*
		5. 1102	1852	12.47	20.58	*		*	*	

* Groups are significantly different via Scheffe's post-hoc test at $p < 0.001$.

Diagnostic Codes:

- 502: Low back strain / sprain
- 808: Hand / wrist laceration
- 501: Low back regional pain
- 602: Shoulder strain / sprain
- 1102: Ankle, foot strain / sprain

5.2.5. Hypothesis 5 – CPT-4 Codes and Outcome Variables

CPT-4 codes as an independent variable were not suitable for statistical analyses. This is because CPT-4 codes do not specify which procedures were undertaken at a given visit, but rather that a particular visit took place. For example, CPT-4 code number 99211 is used to describe the assessment of an established patient. However, the procedure could vary from a geriatrician providing a monthly vitamin B12 injection to a plastic surgeon removing uncomplicated facial sutures. CPT-4 codes, however, were used to determine the independent variable location of initial visit in hypothesis 14.

5.2.6. Hypothesis 6 – Claimant Comorbidity and Outcome Variables

The ability to abstract comorbidity data was limited; therefore, this analysis was not completed. Specifically, comorbidity data was expected to be based on secondary ICD-9 codes, but this information not always available in the data set.

5.2.7. Hypothesis 7 – Claimant Location and Outcome Variables

The *a priori* independent variable for this analysis was zip code of claimant. However, this data field was sparsely populated and this analysis could not be done. However, a closely related analysis (see hypothesis 16) was calculated using the zip code of the provider and matching this to the TWCC region of service.

5.2.8. Hypothesis 8 – Pre-Injury Wage and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if relationships existed between the log of the pre-injury wage and: (a) medical service utilization; (b) expenditure; and (c) lost time. Table 26 provides details of the eight outcome variables analyzed, descriptive information, and results from the statistical tests.

Table 26: Pearson correlation results: outcome variables assessing medical service utilization, expenditure, and time off work with log of pre-injury wage

	Variable Name	N	Mean (S.D.)	\$ Mean	Correlation	Significance
IV	Log of pre-injury wage	77,090	6.12 (0.56)	\$527.40	-	-
MSU	No. of office visits	280,770	8.15 (20.14)	-	-0.03	$p < 0.001$
	No. of hospital visits	280,770	0.91 (2.20)	-	0.04	$p < 0.001$
	No. of ED visits	280,770	0.22 (0.57)	-	-0.01	$p = 0.007$
	No. of visits elsewhere	280,770	39.03 (104.17)	-	0.00	$p = 0.310$
Expenditure	Log of medical payments	280,770	6.39 (1.92)	\$3,642.80	0.07	$p < 0.001$
	Log of lost time benefits	83,446	7.74 (1.62)	\$6,450.04	0.25	$p < 0.001$
	Log of total expenditure	293,361	6.60 (2.05)	\$5,321.15	0.18	$p < 0.001$
TO	No. of weeks off work	83,382	18.67 (25.83)	-	0.02	$p < 0.001$

IV = The independent variable for this hypothesis
MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
TO = Time off from work based on number of weeks lost time benefits received
Note: Mean dollar values are for descriptive purposes only; statistical tests were conducted using log values

Statistical Results: Pearson correlation results show six of the eight analyses achieved statistical significance at $p < 0.001$. The only two dependent variables that did not achieve statistical significance were number of ED visits and number of visits elsewhere at $p = 0.007$ and $p = 0.310$, respectively. These results indicate little variation in medical service utilization, expenditure, or time off accounted for by log of pre-injury wage. The correlation coefficient between the log of weekly pre-injury wage and log of lost time benefits showed the highest correlation at 0.25, yet this correlation is still considered weak. Two of the eight correlation coefficients have a negative relationship and both are associated with medical service utilization. Table 27 provides an outcome summary for analyses associated with hypothesis 8.

Table 27: Outcome summary for analyses associated with hypothesis 8

#	Hypothesis	Rejected?	Direction
	There is no relationship between log of pre-injury wage and the …		
8.1	… number of office visits	Yes	Negative
8.2	… number of hospital visits	Yes	Positive
8.3	… number of emergency department visits	No	N/A
8.4	… number of visits elsewhere	No	N/A
8.5	… log of medical payments	Yes	Positive
8.6	… log of lost time benefits	Yes	Positive
8.7	… log of total expenditure	Yes	Positive
8.8	… number of weeks off work due to injury	Yes	Positive

5.2.9. Hypothesis 9 – Number of Office Visits and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if relationships existed between the number of office visits a claimant made and: (a) expenditure; and (b) lost time. Table 28 provides details of the four outcome variables analyzed, descriptive information, and results from the statistical tests.

Table 28: Pearson correlation results: outcome variables assessing medical service utilization, expenditure, and time off work with number of office visits

	Variable Name	N	Mean (S.D.)	$ Mean	Correlation	Significance
IV	No. of office visits	280,770	8.15 (20.14)	-	-	-
Expenditure	Log of medical payments	280,770	6.39 (1.92)	$3,642.80	0.54	p < 0.001
	Log of lost time benefits	83,446	7.74 (1.62)	$6,450.04	0.34	p < 0.001
	Log of total expenditure	293,361	6.60 (2.05)	$5,321.15	0.53	p < 0.001
TO	No. of weeks off work	83,382	18.67 (25.83)	-	0.40	p < 0.001

IV = The independent variable for this hypothesis
TO = Time off from work based on number of weeks lost time benefits received
Note: Mean dollar values are for descriptive purposes only; statistical tests were conducted using log values

Statistical Results: The Pearson correlations showed statistically significant relationships at the pre-determined alpha level of $p \leq 0.001$ for all four outcome variables. All four variables had correlation coefficients that are considered moderate in strength and positive in direction. Correlation coefficients ranged from 0.34 to 0.54 for expenditure, with log of total expenditure and log of medical payment exhibiting positive coefficients of 0.53 and 0.54, respectively. There was also a positive correlation between number of office visits and number of weeks off work at 0.40. These moderate coefficients indicate that some of the variation in medical expenditure and time off work may be accounted for the by the number of office visits that occur for each claim. Table 29 provides an outcome summary for analyses associated with hypothesis 9.

Table 29: Outcome summary for analyses associated with hypothesis 9

#	Hypothesis	Rejected?	Direction
	There is no relationship between number of office visits and the …		
9.1	… log of medical payments	Yes	Positive
9.2	… log of lost time benefits	Yes	Positive
9.3	… log of total expenditure	Yes	Positive
9.4	… number of weeks off work due to injury	Yes	Positive

5.2.10. Hypothesis 10 – Time Off Work and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if relationships existed between time off work due to injury and: (a) medical service utilization; and (b) expenditure. Table 30 provides details of the seven outcome variables analyzed, descriptive information, and results from the statistical tests.

Table 30: Pearson correlation results: outcome variables assessing medical service utilization, expenditure, and time off work

	Variable Name	N	Mean (S.D.)	S.D.	Correlation	Significance
IV	No. weeks off work	83,382	18.67 (25.83)	-	-	-
MSU	No. of office visits	280,770	8.15 (20.14)	-	0.40	$p < 0.001$
	No. of hospital visits	280,770	0.91 (2.20)	-	0.30	$p < 0.001$
	No. of ED visits	280,770	0.22 (0.57)	-	0.07	$p < 0.001$
	No. of visits elsewhere	280,770	39.03 (104.17)	-	0.41	$p < 0.001$
Expenditure	Log of medical payments	280,770	6.39 (1.92)	$3,642.80	0.45	$p < 0.001$
	Log of lost time benefits	83,446	7.74 (1.63)	$6,450.04	0.72	$p < 0.001$
	Log of total expenditure	293,361	6.60 (2.05)	$5,321.15	0.62	$p < 0.001$

IV = The independent variable for this hypothesis
MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
Note: Mean dollar values are for descriptive purposes only; statistical tests were conducted using log values

Statistical Results: The Pearson correlations showed statistically significant relationships at the pre-determined alpha level of $p \leq 0.001$ for all seven outcome variables. One variable had a weak correlation coefficient, three had moderate correlation coefficients, and two had strong correlation coefficients. The weakest correlation coefficient was 0.07 and was for the variable number of ED visits. Moderate correlation coefficients were found for number of hospital visits (0.30), number of office visits (0.40), number of visits elsewhere (0.41), and log of medical payment (0.45). Log of total expenditure and log of lost time benefits exhibited the strongest correlation coefficients at 0.62 and 0.72, respectively. Likewise, correlation coefficients between the three expenditure variables and time off work due to injury exhibited a positive direction and moderate to high strength (ranging from 0.47 to 0.71). Table 31 provides an outcome summary for analyses associated with hypothesis 10.

Table 31: Outcome summary for analyses associated with hypothesis 10

#	Hypothesis	Rejected?	Direction
	There is no relationship between number of weeks off work and the …		
10.1	… number of office visits	Yes	Positive
10.2	… number of hospital visits	Yes	Positive
10.3	… number of emergency department visits	Yes	Positive
10.4	… number of visits elsewhere	Yes	Positive
10.5	… log of medical payments	Yes	Positive
10.6	… log of lost time benefits	Yes	Positive
10.7	… log of total expenditure	Yes	Positive

5.2.11. Hypothesis 11 – Pre-Injury Number of Hours Worked and Outcome Variables

Data on pre-injury wage was sparsely reported. In addition, the information that was reported was deemed to be inaccurate. This analysis was not completed.

5.2.12. Hypothesis 12 – Practice Type and Outcome Variables

Information on practice type (i.e., single or partners) could not be determined and this analysis was not completed.

5.2.13. Hypothesis 13 – Physician Specialty and Outcome Variables

Data on physician specialty was not readily available in the TWCC dataset. In addition, the ability to extract physician license numbers and compare them with physician specialty on file with the Texas Board of Medical Examiners was limited due to the method in which physician license numbers were coded in the TWCC data set. Therefore, the available information on physician specialty was not in a useable format for data analysis.

5.2.14. Hypothesis 14 – Location of Initial Physician Visit and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if differences existed among the locations in which the initial physician visit occurred (e.g., the office, emergency department, or "elsewhere") for: (a) expenditure; and (b) lost time. The one-way analysis of variance test was used to compare mean values across each of the initial service visit locations for each dependent variable. Table 32 provides inferential results for hypothesis 14.

Table 32: One-way ANOVA results: outcome variables assessing medical service utilization, expenditure, and time off work by location of initial physician visit

	Variable Name	Group	df	Mean Sq.	F	Significance
Expenditure	Log of medical payments	Between	2	1821.96	494.24	p < 0.001
		Within	280,598	3.69		
		Total	280,600			
	Log of lost time benefits	Between	2	171.74	66.88	p < 0.001
		Within	70,773	2.57		
		Total	70,775			
	Log of total expenditure	Between	2	972.93	229.63	p < 0.001
		Within	280,598	4.24		
		Total	280,600			
TO	No. of weeks off work	Between	2	21,238.79	30.30	p < 0.001
		Within	70,729	700.92		
		Total	70,731			

TO = Time off from work based on number of weeks lost time benefits received

Statistical Results: The one-way ANOVA showed significant differences in the omnibus F-Test at the pre-determined alpha level of $p = 0.001$ among locations in which the initial physician visit occurred for medical expenditure and time off from work. Table 33 provides an outcome summary for analyses associated with hypothesis 14.

Table 33: Outcome summary for analyses associated with hypothesis 14

#	Hypothesis	Rejected?
	There is no relationship between location of initial visit and the …	
14.1	… log of medical payments	Yes
14.2	… log of lost time benefits	Yes
14.3	… log of total expenditure	Yes
14.4	… number of weeks off work due to injury	Yes

For log of medical payments, injuries first treated in the ED ($4,000.88) are more expensive than those treated in a physician's office (3,522.82) or at another location ($3,675.93). Likewise, injuries first treated at another location ($3,675.93) are more expensive than those initially treated in a physician's office ($3,522.82). However, when log of lost time benefits are considered, injuries initially treated in the emergency department have less overall costs than injures first treated in a physicians office or at another location ($6,433.17 vs. $6,730.74 and $7,290,24, respectively). In terms of time off, patients initially seen in the ED had, on average, 1.35 and 2.45 *less* weeks off from work than patients who were initially seen in the physician's office and "elsewhere," respectively. Likewise, patients who where initially seen in the physician's office had an average of slightly more than one more week off from work than those seen "elsewhere" in the first instance. A summary of post-hoc results is provided in Table 34.

Table 34: Post-hoc test results for outcome variables assessing medical service utilization, expenditure, and time off work by location of initial physician visit

	Variable Name	Location of Initial Physician Visit	N	Mean	$ Value	SD	Significant Group Differences*		
							ED	MD	Other
MSU	No. of office visits	1. ED	48230	5.81	-	17.62		*	
		2. MD Office	164370	9.87	-	21.76	*		*
		3. Other	68001	5.64	-	17.05		*	
	No. of hospital visits	1. ED	48230	1.71	-	2.70		*	*
		2. MD Office	164370	0.53	-	1.77	*		*
		3. Other	68001	1.25	-	2.52	*	*	
	No. of ED visits	1. ED	48230	1.18	-	0.63		*	*
		2. MD Office	164370	0.02	-	0.25	*		*
		3. Other	68001	0.04	-	0.38	*	*	
	No. of visits elsewhere	1. ED	48230	32.88	-	100.39		*	
		2. MD Office	164370	43.59	-	109.14	*		*
		3. Other	68001	32.37	-	93.37		*	
Expenditure	Log of medical payments	1. ED	48230	6.60	$4,000.88	1.74		*	*
		2. MD Office	164370	6.39	$3,522.82	1.89	*		*
		3. Other	68001	6.24	$3,675.93	2.11	*	*	
	Log of lost time benefits	1. ED	11784	7.69	$6,433.17	1.66		*	*
		2. MD Office	41307	7.84	$6,730.74	1.59	*		*
		3. Other	17685	7.91	$7,290.24	1.61	*	*	
	Log of total expenditure	1. ED	48230	6.73	$5,572.45	1.87		*	*
		2. MD Office	164370	6.57	$5,214.03	2.03	*		*
		3. Other	68001	6.47	$5,571.64	2.25	*	*	
TO	No. of weeks off work	1. ED	11776	18.39	-	26.10		*	*
		2. MD Office	41286	19.75	-	26.16	*		*
		3. Other	17670	20.84	-	27.44	*	*	

* Groups are significantly different via Scheffe's post-hoc test at p < 0.001.
Note: Dollar values are for descriptive purposes only; statistical tests were conducted using log transformations

5.2.15. Hypothesis 15 – Provider Type and Medical Payment

The purpose of the analyses for this hypothesis was to determine if differences existed among the eight provider types with regard to log of medical payments. The eight providers are classified as: (1) medical doctor; (2) doctor of osteopathy; (3) physician's assistant; (4) doctor of chiropractic; (5) physical therapist; (6) occupational therapist; (7) doctor of optometry; (8) and other providers.

Two statistical procedures were used to analyze this hypothesis. Each procedure answers slightly different questions by using different segments of the patient population. The first procedure, a one-way ANOVA, analyzes data at the claim level (i.e., the analysis includes only those claimants who actually had a service visit to that provider type). For example, if 42% of claimants saw a chiropractor, the mean medical payment amount for chiropractors would be based on only those claims. The second procedure, a repeated measures ANOVA, analyzes claims at the system-level and includes all patients in the dataset in each provider type. For those who did not see a particular provider, the payment value is set to $0. The mean medical payment value for each provider type is consequently based on the entire claim population. It should be noted that the two approaches are neither right nor wrong; rather they merely answer slightly different questions. The former answers the question from a claim perspective while the latter answers the question from a system perspective. Results of the one-way ANOVA (claim perspective) are reported first, followed by results form the repeated measures ANOVA (system perspective). Table 35 provides a descriptive summary of the means and standard deviations for both the one-way ANOVA and repeated measures ANOVA by provider type for hypothesis 15.

Table 35: Cost per provider type results using the one-way ANOVA and repeated measures ANOVA results for both transformed and untransformed data

Provider Type	One-Way ANOVA Mean $ (S.D.)	Repeated Measures Mean $ (S.D.)	One-Way ANOVA Log (S.D.)	Repeated Measures Log (S.D.)
MD	$1,392.40 ($3,780.67)	$984.68 ($3,241.85)	5.79 (1.70)	4.09 (3.00)
DO	$670.02 ($2,090.67)	$94.00 ($816.95)	5.36 (1.48)	0.75 (1.94)
PA	$285.56 ($623.65)	$5.76 ($97.21)	4.81 (1.49)	0.10 (0.71)
DC	$4,646.02 ($6,819.70)	$491.46 ($2,638.45)	7.27 (2.05)	0.77 (2.33)
PT	$1,617.03 ($2,744.39)	$277.24 ($1,289.48)	6.48 (1.53)	1.11 (2.52)
OT	$1,614.93 ($2,861.55)	$49.17 ($571.22)	6.29 (1.76)	0.19 (1.12)
OD	$155.10 ($393.55)	$0.34 ($19.66)	4.55 (1.01)	0.01 (0.22)
Other	$1,288.55 ($4,456.47)	$205.86 ($1,842.73)	5.58 (2.04)	0.89 (2.20)

Note: Statistical analyses were conducted using transformed data; untransformed data is presented here for descriptive purposes.

5.2.15.1. One-Way ANOVA Results for Hypothesis 15

The one-way analysis of variance test was used to compare mean values across each of the eight health provider types for medical expenditure. Table 36 provides inferential results for hypothesis 15 using the one-way ANOVA Test. Post-hoc result summary are provided in Table 37.

Table 36: One-way ANOVA results: outcome variables assessing medical expenditure by healthcare practitioner type

	Variable Name	Group	df	Mean Sq.	F	Significance
E	Log of medical payments	Between	7	16796.97	5,621.71	p < 0.001
		Within	444,493	2.99		
		Total	444,500			

E = Expenditure variable

The one-way ANOVA showed a statistically significant omnibus F-Test at the pre-determined alpha level of p = 0.001 among the eight healthcare practitioner types for log of medical payments. Most of the post-hoc comparisons are statistically significant at $p < 0.001$ (see Table 32). Because the Scheffé post-hoc test is not available for the repeated measures ANOVA procedure, post-hoc tests for this hypothesis were conducted using the Bonferroni multiple comparison procedure. Please note that statistical comparisons were based on payment values transformed with the natural logarithm; untransformed payment values are for descriptive purposes only.

There are several findings from the post-hoc results that may be practically as well as statistically significant. For example, chiropractic care costs more, on average, than care provided by each of the other seven providers. Chiropractic care costs $3,253.62 more than care provided by a medical doctor, $3,975,99 more than care provided by an osteopath, and $3,028.98 and $3,031.08 more than care provided by physical and occupational therapists, respectively (all mean differences with a $p < 0.001$). Likewise, medical payments for claimants seeing an allopathic physician (MD) vs. an osteopathic physician (OD) are greater (mean difference: $722.37; $p < 0.001$). The mean difference between costs for injuries treated with physical vs. occupational therapy was statistically significant (mean difference: $2.10; $p < 0.001$), yet this difference is not likely to be practically meaningful. However, if PT and OT costs are bundled with MD costs in order to account for the fact that allopathic physicians do not provide office-based physical manipulation *and* these costs are compared to chiropractors, who do provide office-based physical manipulation, mean chiropractor costs remain statistically and practically significantly higher than MD costs. For example, mean combined MD, OT, and PT medical expenditures are $4,220.46 vs. $5,083.38 ($p \leq 0.001$; mean difference of

-$862.92 for combined care). Mean time-loss costs for chiropractors were $6,967.51 vs. $6,908.15 for combined MD, OT, and PT group costs ($p \leq 0.001$; mean difference of -$530.05 for combined care). Mean total benefit costs were more expensive for chiropractors than the combined MD, OT, and PT group at $6,221.30 vs. $7,534.41, respectively ($p \leq 0.001$; mean difference of - $1,313.12 for combined care).

If prescription costs are also added to MD medical expenditures, this will better represent total costs associated with allopathic physician care. Estimates of prescription expenditure range from about 10.1% at the Texas Mutual Insurance Company to about 12.2% nationwide as a percentage of total medical expenditure. Although specific claim data is not available for prescription use in this database, applying the mean of this range (11.15%), would increase MD only medical expenditures by $155.23 per claimant and combined MD, OT, and PT medical expenditures by $470.58 per claimant. Inferential analyses were not conducted to lack of patient level data on prescription expenditure.

Table 37: Post-hoc summary for comparisons of medical expenditure by practitioner type using one-way ANOVA

	Variable Name	Type	N	Mean	SD	Significant Group Differences*							
						1	2	3	4	5	6	7	8
Expenditure	Log of medical payments	1. MD	235069	5.79	1.70		*	*	*	*	*	*	*
		2. DO	46638	5.36	1.48	*		*	*	*	*	*	*
		3. PA	6700	4.81	1.49	*	*		*	*	*		*
		4. DC	35161	7.27	2.05	*	*	*		*	*	*	*
		5. PT	56989	6.48	1.53	*	*	*	*		*	*	*
		6. OT	10121	6.29	1.76	*	*	*	*	*		*	*
		7. OP	719	4.55	1.01	*	*		*	*	*		*
		8. Other	53104	5.58	2.04	*	*	*	*	*	*	*	

* Groups are significantly different via Bonferroni's post-hoc test at $p < 0.001$.

5.2.15.2. Repeated Measures ANOVA Tests for Hypothesis 15

The repeated measures ANOVA was used to compare mean values across each of the eight health provider types for medical expenditure including all claimants in the dataset. Provider means in the repeated measures analysis are based on actual payment if the provider was used and a value of $0 if the provider was not used. Results of the repeated measures procedure show that the Mauchly's test of sphericity was not met $W(5) = 0.00$, $p \leq 0.001$. Since the data represent a multivariate normal distribution and the sphericity assumption was not met, the Hotelling's Trace multivariate test is used to determine statistical significance among the repeated measures. A mean value payment by provider is provided in Table 30. Please note that statistical comparisons were based on payment values transformed with the natural logarithm; untransformed payment values are for descriptive purposes only.

Like the one-way ANOVA, results of the repeated measures procedure are statistically significant at $p < 0.001$. (Hotelling's Trace = 0.123; F=5823.65(7)). Most of the post-hoc comparisons were statistically significant (see Table 38). Interestingly, while the post-hoc results are statistically significant they vary in magnitude when compared to the one-way ANOVA post-hoc results. This is to be expected since the repeated measures procedure included values of $0 for all provider types that did not have an actual payment, thus lowering the overall mean log of medical payment for each practitioner type.

Similar trends were seen in the repeated measures post-hoc comparisons as were seen in the one-way ANOVA post-hoc comparisons. Interestingly, chiropractic care, which was statistically different among all providers in the one-way ANOVA, reached statistical significance for only six providers in the repeated measures analysis. The mean difference between chiropractic and osteopathic care (DC vs. DO) was not significant (mean difference $397.45; p = 0.018).

Table 38: Post-hoc results for comparisons of medical expenditure by practitioner type using repeated measures ANOVA

	Variable Name	Type	N	Mean	SD	Significant Group Differences*							
						1	2	3	4	5	6	7	8
Expenditure	Log of medical payments	1. MD	332398	4.09	3.00		*	*	*	*	*	*	*
		2. DO	332398	0.75	1.94	*		*		*	*	*	*
		3. PA	332398	0.10	0.71	*	*		*	*	*	*	*
		4. DC	332398	0.77	2.33	*		*		*	*	*	*
		5. PT	332398	1.11	2.52	*	*	*	*		*	*	*
		6. OT	332398	0.19	1.12	*	*	*	*	*		*	*
		7. OP	332398	0.89	2.20	*	*	*	*	*	*		*
		8. Other	332398	0.01	0.22	*	*	*	*	*	*	*	

* Groups are significantly different via Bonferroni's post-hoc test at p < 0.001.
MD = allopathic physician; DO = osteopathic physician; PA = physician's assistant; DC = chiropractor; PT = physical therapist; OT = occupational therapist; OP = other provider as classified by TWCC; Other = other providers not classified by TWCC.

In the repeated measures ANOVA, chiropractors, while costing significantly more than all other providers except osteopathic and allopathic physicians, had much lower mean differences than previously reported in the one-way ANOVA claim-perspective analysis. Indeed, when using the system-wide comparison, chiropractor costs were, on average, $493.22 less than corresponding allopathic physician medical costs. This result, while statistically significant, is probably not practically meaningful due to the high number of cases that actually had physician medical care and thus a non-zero value (n=235,609) vs. the low number who had chiropractor care (n=35,161). That is, 297,237 claimants did not have chiropractor care. In the repeated measures ANOVA, these claimants would therefore have a payment value of $0, bringing down the mean medical cost for chiropractor care. Comparisons of this mean to that for MD care, which has a relatively high mean (i.e., only 96,789 had no care and a value of $0), therefore reflects favorably on chiropractic care. However, this is not necessarily a true reflection of the system-wide chiropractic financial impact.

5.2.15.3. Cost Per Injury Group by Provider Type

An additional analysis was conducted to determine if there were differences in cost per injury group by provider type. In particular, the medical expenditure for the top five injury groups, as identified in Table 16, were compared across three provider types (allopathic physicians, osteopathic physicians, and chiropractors) to determine if there were differences in medical expenses between the three providers for each injury. Table 39 presents results of this analysis.

Table 39: Cost of care for the top 5 injury groups by allopathic physicians (MD), osteopathic physicians (DO), and chiropractors (DC)

Injury Type	MD Care*			DO Care			DC Care		
	Mean $	S.E. Mean	99.9% CI	Mean $	S.E. Mean	99.9% CI	Mean $	S.E. Mean	99.9% CI
502 (Low back strain / sprain)	$1,938	33.29	$1,808 - $2,068	$916	36.73	$773 - $1,059	$4,611	83.57	$4,286 - $4,936
808 (Hand / wrist laceration)	$449	8.82	$414 - $483	$227	6.66	$201 - $253	$3787	389	$2,272 - $5,303
501 (Low back regional pain)	$2,233	55.14	$2,018 - $2,448	$803	40.80	$644 - $952	$4,197	130.68	$3,688 - $4,706
602 (Shoulder strain / sprain)	$1,899	43.67	$1,729 - $2,069	$859	49.39	$667 – 1,052	$5,036	194.86	$4,278 - $5,795
1102 (Ankle / foot strain / sprain)	$735	22.08	$649 - $821	$445	38.83	$294 - $596	$3,925	227.32	$3,039 - $4,810

* Note this does not include costs of prescription medications
MD = allopathic physician
DO = osteopathic physician
DC = chiropractic physician

Results: Due to the file structure, ANOVAs were not conducted for this analysis. Rather, mean expenditure for each injury type for each provider type were determined as was the 99.9% confidence interval for each set of results using the following formula:

Mean expenditure ± (z-score) (standard error)

Mean expenditure ± (3.894) (standard error)

Regardless of injury group, chiropractic care costs were significantly higher ($p < 0.001$) than allopathic physician and osteopathic physician care costs. Likewise, allopathic physician care costs were significantly higher across all injury groups than osteopathic care costs for all injury groups ($p < 0.001$). This indicates that of these three provider types, chiropractic care is most costly for these five injury types.

5.2.16. Hypothesis 16 – TWCC Region of Service and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if differences existed across the four TWCC service regions with regard to: (a) medical service utilization; (b) expenditure; and (c) lost time. The one-way analysis of variance test was used to compare mean values across each of the four TWCC regions for each dependent variable. Table 40 provides inferential results for hypothesis 16.

Table 40: One-way ANOVA results: outcome variables assessing medical service utilization, expenditure, and time off work by TWCC region

	Variable Name	Group	df	Mean Sq.	F	Significance
MSU	No. of office visits	Between	3	145,261.15	99.16	p < 0.001
		Within	31,167	1464.87		
		Total	31,170			
	No. of hospital visits	Between	3	245.43	19.09	p < 0.001
		Within	31,167	12.86		
		Total	31,170			
	No. of ED visits	Between	3	8.72	14.93	p < 0.001
		Within	31,167	0.58		
		Total	31,170			
	No. of visits elsewhere	Between	3	4,366,434.49	119.16	p < 0.001
		Within	31,167	36,643.58		
		Total	31,170			
Expenditure	Log of medical payments	Between	3	140.06	36.65	p < 0.001
		Within	31,167	3.82		
		Total	31,170			
	Log of lost time benefits	Between	3	80.59	35.96	p < 0.001
		Within	28,913	2.24		
		Total	28,916			
	Log of total expenditure	Between	3	136.70	39.53	p < 0.001
		Within	34,878	3.46		
		Total	34,881			
TO	No. of weeks off work	Between	3	17,921.06	21.40	p < 0.001
		Within	28,892	837.33		
		Total	28,895			

MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
TO = Time off from work based on number of weeks lost time benefits received

The one-way ANOVA showed significant differences in the omnibus F-Test at the pre-determined alpha level of $p = 0.001$ among the four TWCC regions for: (a) medical service utilization; (b) medical expenditure; and (c) time off from work. Most post-hoc comparisons showed significant differences in the dependent variables among the TWCC regions. Table 41 provides an outcome summary for analyses associated with hypothesis 16. Summary post-hoc results are provided in Table 42. Post-hoc results show differences in mean utilization between visits to the physician's office and visits "elsewhere" by TWCC region. In addition, there are differences in the mean number of weeks off by TWCC region.

Table 41: Outcomes summary for analyses associated with hypothesis 16

#	Hypothesis	Rejected?
	There is no relationship between TWCC region of service and the …	
16.1	… number of office visits	Yes
16.2	… number of hospital visits	Yes
16.3	… number of emergency department visits	Yes
16.4	… number of visits elsewhere	Yes
16.5	… log of medical payments	Yes
16.6	… log of lost time benefits	Yes
16.7	… log of total expenditure	Yes
16.8	… number of weeks off work due to injury	Yes

Statistical Results: In general, claims adjudicated in Dallas and Houston range from $2,522 to $4,908 higher than claims adjudicated in Austin / San Antonio and West Texas. These differences are statistically significant. In terms of medical service utilization, claims adjudicated in Dallas have 6.50 more office visits than claims adjudicated in Austin / San Antonio. When compared to West Texas, claims in Dallas have an additional 10.26 office visits and claims in Houston have 8.67 more office visits. Likewise, Dallas and Houston have 6.49 and 4.89 more visits than Austin / San Antonio. Time off for claims adjudicated in Houston had 2.95, 2.99 and 3.66 more weeks off than claims adjudicated in Dallas, Austin / San Antonio, and West Texas, respectively.

Table 42: Post-hoc test results for outcome variables assessing medical service utilization, expenditure, and time off work by TWCC region of medical service

	Variable Name	TWCC Region of Medical Visit	N	Mean	SD	Significant Group Differences*			
						1	2	3	4
MSU	No. of office visits	1. D/FW	11913	30.12	42.21			*	*
		2. Houston	7709	28.52	40.73			*	*
		3. Austin/SA	7215	23.62	33.59	*	*		*
		4. West Texas	4334	19.85	28.45	*	*	*	
	No. of hospital visits	1. D/FW	11913	2.07	3.72				*
		2. Houston	7709	2.17	3.34			*	
		3. Austin/SA	7215	1.89	3.49		*		*
		4. West Texas	4334	2.39	3.80	*		*	
	No. of ED visits	1. D/FW	11913	0.25	0.78				
		2. Houston	7709	0.29	0.77			*	
		3. Austin/SA	7215	0.22	0.64		*		*
		4. West Texas	4334	0.30	0.90			*	
	No. of visits elsewhere	1. D/FW	11913	144.98	204.95			*	*
		2. Houston	7709	153.69	219.85			*	*
		3. Austin/SA	7215	115.31	165.41	*	*		*
		4. West Texas	4334	96.29	128.71	*	*	*	
Expenditure	Log of medical payments	1. D/FW	11913	8.40	1.98			*	*
		2. Houston	7709	8.43	2.03			*	*
		3. Austin/SA	7215	8.14	1.94	*	*		
		4. West Texas	4334	8.26	1.78	*	*		
	Log of lost time benefits	1. D/FW	11038	8.24	1.45			*	*
		2. Houston	7277	8.28	1.57			*	*
		3. Austin/SA	6492	8.07	1.50	*	*		
		4. West Texas	4110	8.07	1.48	*	*		
	Log of total expenditure	1. D/FW	13206	8.87	1.88			*	*
		2. Houston	8749	8.89	1.92			*	*
		3. Austin/SA	8008	8.63	1.85	*	*		
		4. West Texas	4919	8.71	1.72	*	*		
TO	No. of weeks off work	1. D/FW	11031	24.27	27.99		*		
		2. Houston	7269	27.22	30.93	*		*	*
		3. Austin/SA	6490	24.23	29.09		*		
		4. West Texas	4106	23.56	27.51		*		

* Groups are significantly different via Scheffe's post-hoc test at $p < 0.001$.

5.2.17. Hypothesis 17 – Specialization and Outcome Variables

Information on physician specialization was not available in this dataset and this analysis was not conducted.

5.2.18. Hypothesis 18 – Carrier and Outcome Variables

The purpose of the analyses for this hypothesis was to determine if differences existed among the top five carriers by claimant use with regard to: (a) medical service utilization; (b) expenditure; and (c) lost time. The one-way analysis of variance test was used to compare mean values across each of the five carriers for each dependent variable. Table 43 provides inferential results for hypothesis 18.

Table 43: One-way ANOVA results: outcome variables assessing medical service utilization, expenditure, and time off work by carrier

	Variable Name	Group	df	Mean Sq.	F	Significance
MSU	No. of office visits	Between	4	13,882.31	25.43	p < 0.001
		Within	67,777	545.95		
		Total	67,781			
	No. of hospital visits	Between	4	388.12	60.76	p < 0.001
		Within	67,777	6.39		
		Total	67,781			
	No. of ED visits	Between	4	20.20	48.92	p < 0.001
		Within	67,777	0.41		
		Total	67,781			
	No. of visits elsewhere	Between	4	913,298.94	69.18	p < 0.001
		Within	67,777	13,202.63		
		Total	67,781			
Expenditure	Log of medical payments	Between	4	9.07	2.84	p = 0.023
		Within	66,969	3.20		
		Total	66,973			
	Log of lost time benefits	Between	4	32.36	12.45	p < 0.001
		Within	17,799	2.60		
		Total	17,803			
	Log of total expenditure	Between	4	41.19	10.96	p < 0.001
		Within	67,016	3.76		
		Total	67,020			
TO	No. of weeks off work	Between	4	12,214.35	16.38	p < 0.001
		Within	17,791	745.76		
		Total	17,795			

MSU = Type of medical service utilization (e.g., office visit, hospital visit, emergency department visit, or elsewhere)
TO = Time off from work based on number of weeks lost time benefits received

The one-way ANOVA showed significant differences in the omnibus F-Test at the pre-determined alpha level of p = 0.001 among the five carriers for medical service utilization and time off from work. The omnibus F-Test was statistically significant for two of the expenditure variables – log of lost time benefits and log of total expenditure. The omnibus F-Test was not significant for the log of medical payments ($p = 0.023$). Table 44 provides an outcome summary for analyses associated with hypothesis 10. Summary post-hoc results are provided in Table 45.

Table 44: Outcomes summary for analyses associated with hypothesis 18

#	Hypothesis	Rejected?
	There is no relationship between the top 5 carriers and the …	
18.1	… number of office visits	Yes
18.2	… number of hospital visits	Yes
18.3	… number of emergency department visits	Yes
18.4	… number of visits elsewhere	Yes
18.5	… log of medical payments	No
18.6	… log of lost time benefits	Yes
18.7	… log of total expenditure	Yes
18.8	… number of weeks off work due to injury	Yes

Statistical Results: Post-hoc comparisons indicate statistically significant differences in the amount of service utilization between carrier group. For mean number of visits, carrier 3 has the fewest mean office visits between the top five carrier groups at 7.84 mean visits per injured worker. In contrast, carrier 2 has 10.56 mean visits per injured worker ($p < 0.001$). For number of hospital visits both carriers 1 and 2 have statistically significant more visits than carriers 3, 4, and 5. Carrier 1 has the most visits as 1.21 and carrier 5 has the fewest visits at 0.87 ($p < 0.001$). A similar pattern emerged for number of emergency department visits. Carriers 1 and 2 had the most mean visits (0.28 and 0.27) while carriers 3, 4, and 5 had the fewest mean visits. Carrier 4 had the fewest visits of the five at 0.19 mean visits, which was statistically significant from carriers 1 and 2 at $p < 0.001$. For expenditure outcome variables, there was no difference in medical expenditure between the five groups ($F = 2.84$; $p = 0.023$); this finding was not unexpected due to TWCC reimbursement guidelines currently in place. However, there were some between group differences for log of lost time benefits paid and log of total expenditure. When assessing time off from work, carrier 4 claimants had the longest mean time off at 23.86 weeks per claimant. There was significantly higher time off for carrier 1, 2, and 5 claimants (19.61, 19.74, and 20.72 weeks, respectively; $p < 0.001$ for all three vs. carrier 4). Carrier 4 had, on average, 3.14 more weeks off than carrier 5 claimants but this difference was not statistically different.

Table 45: Post-hoc test results for outcome variables assessing medical service utilization, expenditure, and time off work by carrier status

	Variable Name	Carrier Code	N	Mean	SD	Significant Group Differences*				
						1	2	3	4	5
MSU	No. of office visits	1. Carrier 1	19908	10.16	25.23			*		
		2. Carrier 2	13384	10.56	25.98		*			
		3. Carrier 3	11907	7.84	19.63	*	*		*	*
		4. Carrier 4	12638	9.56	21.16				*	
		5. Carrier 5	9945	9.44	22.55			*		
	No. of hospital visits	1. Carrier 1	19908	1.21	2.93			*	*	*
		2. Carrier 2	13384	1.09	2.66			*	*	*
		3. Carrier 3	11907	0.94	2.18	*	*			
		4. Carrier 4	12638	0.84	2.35	*	*			
		5. Carrier 5	9945	0.87	2.03	*	*			
	No. of ED visits	1. Carrier 1	19908	0.28	0.67			*	*	*
		2. Carrier 2	13384	0.27	0.76			*	*	*
		3. Carrier 3	11907	0.21	0.52	*	*			
		4. Carrier 4	12638	0.19	0.62	*	*			
		5. Carrier 5	9945	0.24	0.58	*	*			
	No. of visits elsewhere	1. Carrier 1	19908	55.15	149.87		*	*	*	*
		2. Carrier 2	13384	43.81	106.25	*		*		
		3. Carrier 3	11907	35.77	92.13	*	*			
		4. Carrier 4	12638	39.43	87.73	*				
		5. Carrier 5	9945	40.51	99.44	*				
Expenditure	Log of medical payments	1. Carrier 1	19908	6.50	1.89					
		2. Carrier 2	13384	6.51	1.96					
		3. Carrier 3	11907	6.46	1.90					
		4. Carrier 4	12638	6.49	1.95					
		5. Carrier 5	9945	6.52	1.80					
	Log of lost time benefits	1. Carrier 1	6035	7.91	1.60		*			
		2. Carrier 2	3175	7.72	1.68	*			*	
		3. Carrier 3	2403	7.88	1.56					
		4. Carrier 4	3825	7.97	1.64		*			
		5. Carrier 5	2366	7.81	1.57					
	Log of total expenditure	1. Carrier 1	19908	6.71	2.06			*		
		2. Carrier 2	13384	6.64	2.07					
		3. Carrier 3	11907	6.57	2.01	*			*	
		4. Carrier 4	12638	6.71	2.11			*		
		5. Carrier 5	9945	6.68	1.93					
TO	No. of weeks off work	1. Carrier 1	6034	19.61	26.50				*	
		2. Carrier 2	3174	19.74	27.41				*	
		3. Carrier 3	2399	21.55	27.00					
		4. Carrier 4	3826	23.86	28.58	*	*			*
		5. Carrier 5	2363	20.72	27.43				*	

* Groups are significantly different via Scheffe's post-hoc test at $p < 0.001$.

5.2.19. Hypothesis 19 – Regional Rates of Unemployment and Outcome Variables

Because information on claimant zip-code or city of residence was poorly reported in the database, analyses on regional unemployment rates could not be completed.

5.3. Regression Results

Eight models, one for each dependent variable, were estimated. These eight models are briefly summarized in Table 46 and are described in detail in section 5.3.

Table 46: Summary of the best-fit model for each dependent variable using the step-wise method

DV	R^2	Sig.	Predictors (Independent Variables)*
OV	0.070	$p < 0.001$	Dallas, Houston, 502, A/SA, 302, Fem, C2, 808, C1, 810, ED, 501, 802, 602, C4, C5, 1102, C3, Wage
Hosp	0.049	$p < 0.001$	ED, MD, C1, Wage, 501, C2, 1102, Houston, Dallas, C3, 808, A/SA, 302, 802
EDV	0.031	$p < 0.001$	MD, 808, 810, C1, 602, Fem, 502, 802, C2, 501, Wage, A/SA
Other	0.059	$p < 0.001$	Dallas, Houston, C1, MD, A/SA, 502, 302, 808, 602, Fem, 1102, 810, C2, 802, ED, 501
Med	0.060	$p < 0.001$	Dallas, Houston, A/SA, Wage, 1102, MD, 808, ED, G3, 602, C2, 302, Fem, 807, 502, 1004, G1, 810
Ind	0.116	$p < 0.001$	Wage, Dallas, Houston, A/SA, 808, MD, C1, 1102, 302, 501, 502, 602, C4, Fem, 807, C3
Tot	0.132	$p < 0.001$	Wage, Dallas, Houston, A/SA, MD, ED, 502, 602, 302, 501, 1004, C3, C1, C2, Fem, C4, 802, 808, 1102, C5
Wks	0.045	$p < 0.001$	Houston, Dallas, A/SA, 808, 501, 502, MD, 302, C4, Fem, 1102, Wage, 602, 810, ED, C3, C1, 807

* See Table 9 for a description of dependent and independent variables.
DV = dependent variable

5.3.1. Predicting the Number of Office Visits Using TWCC data

The relationship between the number of office visits and the 22 independent variables was assessed using step-wise regression. Table 47 provides details of the model summary and Table 48 provides parameter estimates for the regression model.

Table 47: Model summary for the step-wise regression with number of office visits as the dependent variable

R^2	S.E.	DF	F	Sig.
0.070	32.63	19, 65675	258.37	$p < 0.001$

Note: This model contains the following predictor variables: Dallas, Houston, 502, A/SA, 302, Fem, C2, 808, C1, 810, ED, 501, 802, 602, C4, C5, 1102, C3, and Wage.

Table 48: Parameter estimates for the step-wise regression model with number of office visits as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	20.01	1.51	13.24	$p \leq 0.001$	
Dallas	15.78	0.37	42.15	$p \leq 0.001$	0.021
Houston	14.47	0.46	31.75	$p \leq 0.001$	0.034
502	9.57	0.40	23.69	$p \leq 0.001$	0.042
A/SA	9.32	0.48	19.54	$p \leq 0.001$	0.048
302	11.57	0.63	18.24	$p \leq 0.001$	0.053
Fem	3.20	0.28	11.55	$p \leq 0.001$	0.056
C2	9.33	0.61	15.31	$p \leq 0.001$	0.059
808	-9.41	0.81	-11.67	$p \leq 0.001$	0.061
C1	6.20	0.46	13.60	$p \leq 0.001$	0.063
810	-7.16	0.76	-9.47	$p \leq 0.001$	0.065
ED	-2.83	0.35	-8.16	$p \leq 0.001$	0.066
501	4.58	0.56	8.22	$p \leq 0.001$	0.067
802	5.66	0.83	6.80	$p \leq 0.001$	0.068
602	3.71	0.64	5.84	$p \leq 0.001$	0.068
C4	2.81	0.55	5.12	$p \leq 0.001$	0.069
C5	3.30	0.70	4.70	$p \leq 0.001$	0.069
1102	-3.62	0.81	-4.48	$p \leq 0.001$	0.069
C3	3.05	0.70	4.33	$p \leq 0.001$	0.069
Wage	-0.88	0.24	-3.70	$p \leq 0.001$	0.070

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicate that 19 independent variables were significant predictors of the dependent variable “number of office visits” using the stepwise method. Overall, the 19 variables in this model predicted only 7% of the total variance of the number of office visits for TWCC claimants ($F=258.37$; $df=19, 65,675$; $p \leq 0.001$).

5.3.2. Predicting the Number of Hospitalizations Using TWCC Data

The relationship between the number of hospitalizations and the 22 independent variables was assessed using step-wise regression. Table 49 provides details of the model summary and Table 50 provides parameter estimates for the regression model.

Table 49: Model summary for the step-wise regression with number of hospitalizations as the dependent variable

R^2	S.E.	DF	F	Sig.
0.049	3.54	14, 65680	240.66	$p < 0.001$

Note: This model contains the following predictor variables: ED, MD, C1, Wage, 501, C2, 1102, Houston, Dallas, C3, 808, A/SA, 302, 802.

Table 50: Parameter estimates for the step-wise regression model with number of hospitalizations as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	-0.35	0.16	-2.27	$p = 0.020$	
ED	1.83	0.04	47.19	$p \leq 0.001$	0.026
MD	0.90	0.03	26.87	$p \leq 0.001$	0.036
C1	0.81	0.05	16.46	$p \leq 0.001$	0.039
Wage	0.28	0.03	11.13	$p \leq 0.001$	0.041
501	0.48	0.06	8.08	$p \leq 0.001$	0.042
C2	0.62	0.07	9.40	$p \leq 0.001$	0.044
1102	-0.78	0.09	-8.92	$p \leq 0.001$	0.045
Houston	0.45	0.05	9.11	$p \leq 0.001$	0.046
Dallas	0.38	0.04	9.36	$p \leq 0.001$	0.047
C3	0.51	0.08	6.64	$p \leq 0.001$	0.047
808	-0.51	0.09	-5.90	$p \leq 0.001$	0.048
A/SA	0.28	0.05	5.33	$p \leq 0.001$	0.048
302	-0.32	0.07	-4.69	$p \leq 0.001$	0.048
802	-3.30	0.09	-3.67	$p \leq 0.001$	0.049

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicated that 14 independent variables were significant predictors with the dependent variable "number of hospitalizations" using the stepwise method. Overall, these 14 variables predicted only 4.9% of the total variance in the number of hospitalizations for TWCC claimants ($F=240.66$; $df=14, 65{,}680$; $p \leq 0.001$).

5.3.3. Predicting the Number of ED Visits Using TWCC Data

The relationship between the number of emergency department (ED) visits and the 22 independent variables was assessed using step-wise regression. Table 51 provides details of the model summary and Table 52 provides parameter estimates for the regression model.

Table 51: Model summary for the step-wise regression with the number of emergency department visits as the dependent variable

R^2	S.E.	DF	F	Sig.
0.031	0.76	12, 65682	177.96	p < 0.001

Note: This model contains the following predictor variables: MD, 808, 810, C1, 602, Fem, 502, 802, C2, 501, Wage, A/SA.

Table 52: Parameter estimates for the step-wise regression model with the number of emergency department visits as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	0.48	0.03	13.72	p ≤ 0.001	
MD	-0.26	0.01	-36.68	p ≤ 0.001	0.018
808	0.26	0.02	14.03	p ≤ 0.001	0.022
810	0.19	0.02	10.62	p ≤ 0.001	0.024
C1	0.01	0.01	9.42	p ≤ 0.001	0.026
602	-0.15	0.02	-9.96	p ≤ 0.001	0.027
Fem	-0.06	0.01	-8.82	p ≤ 0.001	0.028
502	-0.08	0.01	-7.99	p ≤ 0.001	0.029
802	-0.14	0.02	-7.41	p ≤ 0.001	0.030
C2	0.10	0.01	6.75	p ≤ 0.001	0.030
501	0.08	0.01	6.04	p ≤ 0.001	0.031
Wage	-0.02	0.01	-3.95	p ≤ 0.001	0.031
A/SA	-0.04	0.01	-3.92	p ≤ 0.001	0.031

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicated that 12 independent variables were significant predictors of the dependent variable "number of ED visits" using the stepwise method. Overall, these 12 variables predicted only 3.1% of the total variance in the number of hospitalizations for TWCC claimants (F=177.96; df=12, 65,682; p ≤ 0.001).

5.3.4. Predicting the Number of "Other" Visits Using TWCC Data

The relationship between the number of "other" visits and the 22 independent variables was assessed using step-wise regression. Other visits are defined as visits to medical practitioners other than an allopathic physician. Table 53 provides details of the model summary and Table 54 provides parameter estimates for the regression model.

Table 53: Model summary for the step-wise regression with the number of "other" visits as the dependent variable

R^2	S.E.	DF	F	Sig.
0.059	170.14	16, 65678	257.07	$p < 0.001$

Note: This model contains the following predictor variables: Dallas, Houston, C1, MD, A/SA, 502, 302, 808, 602, Fem, 1102, 810, C2, 802, ED, 501.

Table 54: Parameter estimates for the step-wise regression model with the number of "other" visits as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	87.28	1.28	68.33		
Dallas	71.66	1.95	36.73	$p \leq 0.001$	0.015
Houston	83.25	2.38	35.05	$p \leq 0.001$	0.031
C1	46.28	2.34	19.75	$p \leq 0.001$	0.036
MD	-25.25	1.62	-15.63	$p \leq 0.001$	0.041
A/SA	41.89	2.49	16.86	$p \leq 0.001$	0.045
502	30.68	2.12	14.48	$p \leq 0.001$	0.048
302	45.92	3.31	13.86	$p \leq 0.001$	0.051
808	-43.17	4.20	-10.27	$p \leq 0.001$	0.053
602	32.84	3.32	9.90	$p \leq 0.001$	0.054
Fem	11.76	1.40	8.38	$p \leq 0.001$	0.056
1102	-29.19	4.29	-6.92	$p \leq 0.001$	0.056
810	-25.20	3.94	-6.39	$p \leq 0.001$	0.057
C2	20.33	3.16	6.43	$p \leq 0.001$	0.058
802	24.73	4.34	5.69	$p \leq 0.001$	0.058
ED	-10.10	1.88	-5.38	$p \leq 0.001$	0.059
501	11.90	2.91	4.10	$p \leq 0.001$	0.059

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicated that 16 independent variables were significant predictors of the dependent variable "other" visits using the stepwise method. Overall, these 16 variables predicted only 5.9% of the total variance in the number of hospitalizations for TWCC claimants (F=257.07; df=16, 65,678; $p \leq 0.001$).

5.3.5. Predicting the Log of Medical Payment Using TWCC Data

The relationship between the log of medical payment and the 22 independent variables was assessed using step-wise regression. Table 55 provides details of the model summary and Table 56 provides parameter estimates for the regression model.

Table 55: Model summary for the step-wise regression for log of medical payment as the dependent variable

R^2	S.E.	DF	F	Sig.
0.060	1.66	18, 65676	233.77	p < 0.001

Note: This model contains the following predictor variables: Dallas, Houston, A/SA, Wage, 1102, MD, 808, ED, CG3, 602, G2, 302, Fem, 807, 502, 1004, CG1, 810.

Table 56: Parameter estimates for the step-wise regression model with log of medical payment as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	6.54	0.08	84.78		
Dallas	0.68	0.02	35.87	p ≤ 0.001	0.014
Houston	0.71	0.02	30.66	p ≤ 0.001	0.027
A/SA	0.51	0.02	21.04	p ≤ 0.001	0.033
Wage	0.24	0.01	19.84	p ≤ 0.001	0.038
1102	-0.68	0.04	-16.59	p ≤ 0.001	0.042
MD	-0.15	0.02	-9.41	p ≤ 0.001	0.046
808	-0.49	0.04	-11.95	p ≤ 0.001	0.048
ED	0.25	0.02	13.80	p ≤ 0.001	0.051
CG3	0.45	0.04	12.69	p ≤ 0.001	0.053
602	0.38	0.03	11.79	p ≤ 0.001	0.054
G2	0.31	0.03	9.88	p ≤ 0.001	0.056
302	0.29	0.03	8.85	p ≤ 0.001	0.057
Fem	0.12	0.01	8.78	p ≤ 0.001	0.058
807	-0.40	0.07	-6.11	p ≤ 0.001	0.058
502	0.13	0.02	6.24	p ≤ 0.001	0.059
1004	0.25	0.04	6.22	p ≤ 0.001	0.059
CG1	0.12	0.03	5.37	p ≤ 0.001	0.060
810	-0.19	0.04	-5.02	p ≤ 0.001	0.060

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicated that 18 independent variables were significant predictors of the dependent variable "log of medical payment" using the stepwise method. Overall, these 18 variables predicted only 6.0% of the total variance in the log of medical payment for TWCC claimants (F=233.77; df=18, 65,676; p

≤ 0.001).

5.3.6. Predicting the Log of Indemnity Payment Using TWCC Data

The relationship between the log of indemnity payment and the 22 independent variables was assessed using step-wise regression. Table 57 provides details of the model summary and Table 58 provides parameter estimates for the regression model.

Table 57: Model summary for the step-wise regression for log of indemnity payment as the dependent variable

R^2	S.E.	DF	F	Sig.
0.116	1.52	16, 76748	628.67	$p < 0.001$

Note: This model contains the following predictor variables: Wage, Dallas, Houston, A/SA, 808, MD, C1, 1102, 302, 501, 502, 602, C4, Fem, 807, C3.

Table 58: Parameter estimates for the step-wise regression model with log of indemnity payment as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	2.8	0.06	43.95		
Wage	0.76	0.01	73.85	$p \leq 0.001$	0.065
Dallas	0.63	0.02	38.65	$p \leq 0.001$	0.077
Houston	0.71	0.02	35.59	$p \leq 0.001$	0.090
A/SA	0.57	0.02	27.58	$p \leq 0.001$	0.100
808	-0.58	0.04	-15.51	$p \leq 0.001$	0.103
MD	0.22	0.01	16.13	$p \leq 0.001$	0.106
C1	0.31	0.02	14.81	$p \leq 0.001$	0.108
1102	-0.43	0.04	-11.53	$p \leq 0.001$	0.110
302	0.35	0.03	11.83	$p \leq 0.001$	0.111
501	0.27	0.03	10.30	$p \leq 0.001$	0.112
502	0.19	0.02	10.10	$p \leq 0.001$	0.113
602	0.30	0.03	10.15	$p \leq 0.001$	0.115
C4	0.19	0.03	7.39	$p \leq 0.001$	0.115
Fem	0.06	0.01	5.57	$p \leq 0.001$	0.115
807	-0.27	0.06	-4.59	$p \leq 0.001$	0.116
C3	0.12	0.03	3.55	$p \leq 0.001$	0.116

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicated that 16 independent variables were significant predictors of the dependent variable "log of indemnity payment" using the stepwise method. Overall, these 16 variables predicted only 11.6% of the total variance in the log of medical payment for TWCC claimants (F=628.67; df=16, 76,748; $p \leq 0.001$).

5.3.7. Predicting the Log of Total Payment Using TWCC Data

The relationship between the log of total payment and the 22 independent variables was assessed using step-wise regression. Table 59 provides details of the model summary and Table 60 provides parameter estimates for the regression model.

Table 59: Model summary for the step-wise regression for log of total payment as the dependent variable

R^2	S.E.	DF	F	Sig.
0.132	1.44	20, 76780	583.65	p < 0.001

Note: This model contains the following predictor variables: Wage, Dallas, Houston, A/SA, MD, ED, 502, 602, 302, 501, 1004, C3, C1, C2, Fem, C4, 802, 808, 1102, C5.

Table 60: Parameter estimates for the step-wise regression model with log of total payment as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	4.87	0.06	79.74	p ≤ 0.001	
Wage	0.54	0.01	56.05	p ≤ 0.001	0.034
Dallas	0.71	0.02	45.63	p ≤ 0.001	0.052
Houston	0.76	0.02	40.23	p ≤ 0.001	0.069
A/SA	0.61	0.02	30.72	p ≤ 0.001	0.080
MD	0.41	0.01	30.82	p ≤ 0.001	0.086
ED	0.44	0.02	28.40	p ≤ 0.001	0.094
502	0.48	0.02	27.36	p ≤ 0.001	0.101
602	0.64	0.03	23.07	p ≤ 0.001	0.106
302	0.61	0.03	21.81	p ≤ 0.001	0.112
501	0.44	0.02	17.89	p ≤ 0.001	0.116
1004	0.49	0.03	14.52	p ≤ 0.001	0.118
C3	0.52	0.03	16.65	p ≤ 0.001	0.121
C1	0.36	0.02	18.19	p ≤ 0.001	0.123
C2	0.37	0.03	13.89	p ≤ 0.001	0.125
Fem	0.13	0.01	11.29	p ≤ 0.001	0.127
C4	0.29	0.02	12.14	p ≤ 0.001	0.128
802	0.36	0.08	9.70	p ≤ 0.001	0.130
808	-0.33	0.04	-9.30	p ≤ 0.001	0.130
1102	-0.29	0.04	-8.12	p ≤ 0.001	0.131
C5	0.23	0.03	7.52	p ≤ 0.001	0.132

* See table 9 for a description of independent variables.

Statistical Results: Results from this exploratory analysis indicated that 20 independent variables were significant predictors of the dependent variable "log of total payment" using the stepwise method. Overall, these 20 variables predicted only 13.2% of the total variance in the log of medical payment (F=583.65; df=20, 76,780; p ≤ 0.001).

5.3.8. Predicting the Number of Weeks off Work Using TWCC Data

The relationship between the number of weeks off work and the 22 independent variables was assessed using step-wise regression. Table 61 provides details of the model summary and Table 62 provides parameter estimates for the regression model.

Table 61: Model summary for the step-wise regression for the number of weeks off work as the dependent variable

R^2	S.E.	DF	F	Sig.
0.045	25.57	18, 76732	200.17	p < 0.001

Note: This model contains the following predictor variables: Houston, Dallas, A/SA, 808, 501, 502, MD, 302, C4, Fem, 1102, Wage, 602, 810, ED, C3, C1, 807.

Table 62: Parameter estimates for the step-wise regression model with the number of weeks off work as the dependent variable

Variable*	Unstandardized *B*	Unstandardized S.E.	T	Significance	Cumulative R^2
Constant	5.85	1.09	5.39	p ≤ 0.001	
Houston	11.40	0.33	34.23	p ≤ 0.001	0.011
Dallas	7.67	0.28	27.89	p ≤ 0.001	0.020
A/SA	8.19	0.36	23.43	p ≤ 0.001	0.028
808	-9.12	0.63	-14.44	p ≤ 0.001	0.031
501	5.92	0.43	13.67	p ≤ 0.001	0.033
502	4.25	0.31	13.65	p ≤ 0.001	0.035
MD	3.30	0.23	14.16	p ≤ 0.001	0.037
302	5.13	0.49	10.40	p ≤ 0.001	0.039
C4	4.68	0.43	10.96	p ≤ 0.001	0.040
Fem	2.22	0.20	11.09	p ≤ 0.001	0.041
1102	-5.30	0.63	-8.40	p ≤ 0.001	0.042
Wage	1.32	0.17	7.67	p ≤ 0.001	0.043
602	3.38	0.49	6.85	p ≤ 0.001	0.043
810	-4.17	0.59	-7.06	p ≤ 0.001	0.044
ED	1.39	0.28	5.06	p ≤ 0.001	0.044
C3	2.47	0.55	4.5	p ≤ 0.001	0.045
C1	1.34	0.35	3.81	p ≤ 0.001	0.045
807	-3.28	0.99	-3.30	p ≤ 0.001	0.045

* See table 9 for a description of independent variables

Statistical Results: Results from this exploratory analysis indicated that 18 independent variables were significant predictors of the dependent variable “number of weeks off” using the stepwise method. Overall, these 18 variables predicted only 4.5% of the total variance in the number of weeks off work for TWCC claimants ($F=200.17$; $df=18, 76{,}732$; $p \leq 0.001$).

5.4. Cost Estimation Model Results

5.4.1. Part 1 – Short-Term Data Extrapolation Results

Four short-term studies had their findings extrapolated for up to ten-years to identify potential long-term cost reductions. Table 63 displays the summary results of short-term data extrapolation with comparison to the baseline study. It should be noted that there is an unknown degree of uncertainty associated with these projections.

Table 63: Percent cost reductions using short-term study findings extrapolated over a ten-year period on a per annum basis

Period	Baseline (Bernacki)*	Arnetz *et al.*	Baldwin *et al.*	Cheadle *et al.*	Lemstra & Olszynski	Average
1	6.99%	21.36%	11.10%	32.30%	41.30%	22.61%
2	10.10%	30.86%	16.04%	46.67%	59.67%	32.67%
3	8.38%	25.62%	13.31%	38.74%	49.53%	27.12%
4	12.06%	36.86%	19.15%	55.73%	71.26%	39.01%
5	5.47%	16.72%	8.69%	25.28%	32.32%	17.69%
6	2.18%	6.67%	3.47%	10.09%	12.90%	7.06%
7	7.28%	22.25%	11.56%	33.65%	43.02%	23.55%
8	-0.25%	-0.77%	-0.40%	-1.17%	-1.49%	-0.82%
9	-4.87%	-14.89%	-7.74%	-22.52%	-28.79%	-15.76%
10	6.91%	21.11%	10.97%	31.92%	40.82%	22.34%
Cumulative	54.24%	165.78%	86.15%	250.68%	320.53%	175.47%
Per Annum	**5.42%**	**16.58%**	**8.62%**	**25.07%**	**32.05%**	**17.55%**

* Only the baseline study had actual figures reported for the entire 10-year period

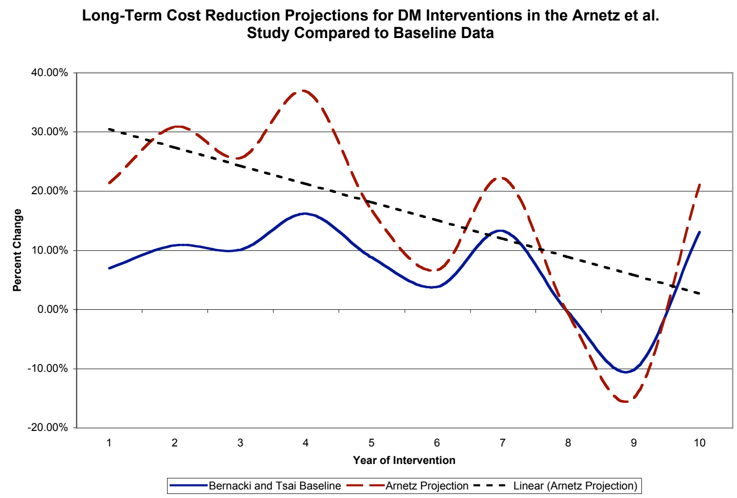
5.4.1.1. Arnetz et al. Data Extrapolation

This study featured five main DM interventions, including early intervention (EI), treatment planning, ergonomic assessment, accommodation, and early RTW activities. When compared to the baseline study, this study had two fewer interventions and did not include network management, occupational medicine, nor physical therapist intervention. The initial short-term cost reduction was 21.36%, not including the cost of the intervention. The initial short term cost reduction value of 21.36% was chosen, rather than the initial short-term cost reduction that did not include the cost of the intervention, because in the cost estimation step, costs of providing the intervention for TWCC participants will be considered. Including the intervention costs now, would in effect, increase the total intervention costs at the time of the cost estimate.

Over ten years, projected long-term cumulative cost reductions reached 165.78% with projected per annum average cost reductions of 16.58%. There was greater variation over time with this data as compared to the baseline data due to greater initial per annum cost reductions in the short-term study than in the baseline study. Trend analysis calculated by Microsoft Excel showed estimated annual savings ranged from 30.44% in year one to 2.72% in year 10.

Figure 11: Long-term extrapolation results for the Arnetz *et al*. study

Study by Arnetz *et al.*		
DM Intervention	Network / PPO	
	Occupational Med	
	Physical Therapist	
	Early Intervention	●
	Guidelines	
	Treatment Planning	●
	Ergonomic Asses	●
	Accommodation	●
	Early RTW	●
% Reduction	Initial Short-Term Per Annum Change	**-21.36%**
	Projected Long-Term Mean Change Per Annum	**-16.58%**
	Projected Long-Term Cumulative Change	**-165.78%**



Linear % Change in Total Cost Reduction = (-0.0308)(Year of Intervention) + 0.3552

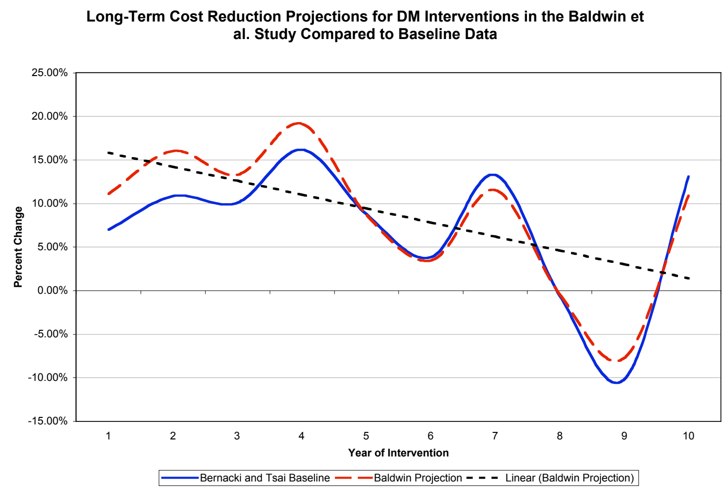
5.4.1.2. Baldwin et al. Data Extrapolation

This study featured four DM interventions, all of which were judged to be less rigorously applied as compared to the baseline study. For example, both studies used preferred provider organizations (PPO) to manage WC care. However, the PPO in the baseline study was specifically established to serve injured workers while not all of the PPOs in Baldwin *et al*. study were established to provide WC care. Likewise, the baseline study used occupational medicine physicians and nurses as the standard practitioner type for treating WC injuries while the PPOs in the Baldwin *et al*. study did not consistently do this. In addition, guidelines and attention to early intervention were more rigorously applied in the baseline study.

Initial short-term per annum cost reductions in this study were 11.1% while projected long-term mean per annum cost reductions decreased slightly to 8.62%. Projected cumulative cost reductions for the 10-year period were 86.15%. Trend analysis using Microsoft Excel showed a gradual decrease in estimated per annum savings from 17.26% to 15.82% over the 10-year period. Generally speaking, there was little variation between baseline study data and the short-term data extrapolation. This is due to the similar initial per annum figures of 11.1% and 5.42% at year one for the Baldwin *et al*. and baseline studies, respectively. Of the four studies reviewed, the Baldwin *et al*. study had the lowest mean per annum and cumulative projected long-term savings.

Figure 12: Long-term extrapolation results for the Baldwin *et al.* study

Study by Baldwin *et al.*		
DM Intervention	Network / PPO	◑
	Occupational Med	◑
	Physical Therapist	
	Early Intervention	◑
	Guidelines	◑
	Treatment Planning	
	Ergonomic Asses	
	Accommodation	
	Early RTW	
% Reduction	Initial Short-Term Per Annum Change	**-11.10%**
	Projected Long-Term Mean Change Per Annum	**-8.62%**
	Projected Long-Term Cumulative Change	**-86.15%**



Linear % Change in Total Cost Reduction = (-0.016)(Year of Intervention) + 0.1742

5.4.1.3. Cheadle et al. Data Extrapolation

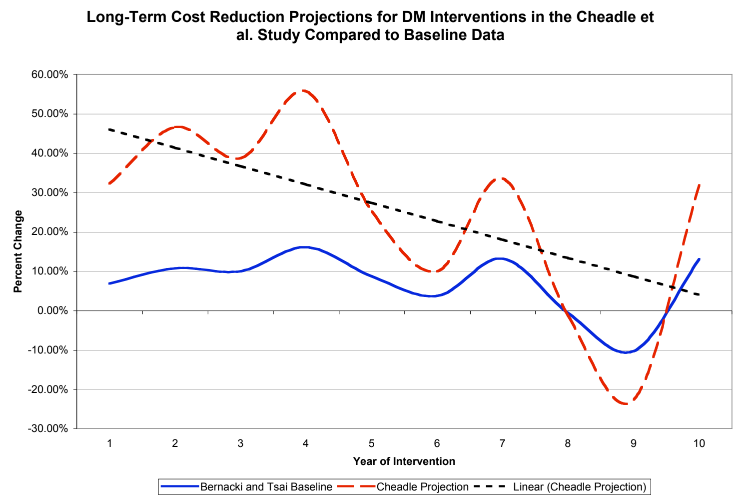
This study reported short-term per annum cost reductions of 32.30%. Projected long-term average per annum cost reductions decreased slightly to 25.07% while the projected 10-year cumulative cost reduction reached 250.68%. Five DM interventions were used in this study, two of which were assessed as being less rigorously applied than the baseline counterparts. The use of occupational medicine staff was judged to be more rigorously applied in the baseline study because these physicians and nurses are highly credentialed and practice in an academic medical center. Furthermore, guideline use in the baseline study was more rigorously applied because these guidelines were developed based on treating WC injuries in a major medical institution. It should be noted, however, that the care delivered in the Washington State model appears to be of very high quality and that the comparison to the baseline is only meant to point out distinctions in the delivery model that may lead to variation in practice patterns. Indeed, the care provided in the Washington State model is likely to be similar to the type of care that may be delivered in a Texas-wide program.

There was greater variation in the long-term findings over time as compared to baseline findings. This is due to the higher initial per annum cost reduction in the Cheadle *et al.* study of 32.30%. Trend analysis by Microsoft Excel showed a projected decrease in per annum cost reductions of 46.03% in year one and 4.09% in year 10.

Figure 13: Long-term extrapolation results for the Cheadle *et al*. study

Study by Cheadle *et al.*

DM Intervention	Network / PPO	●
	Occupational Med	◑
	Physical Therapist	
	Early Intervention	●
	Guidelines	◑
	Treatment Planning	
	Ergonomic Asses	
	Accommodation	
	Early RTW	●
% Reduction	Initial Short-Term Per Annum Change	**-32.30%**
	Projected Long-Term Mean Change Per Annum	**-25.07%**
	Projected Long-Term Cumulative Change	**-250.68%**



Linear % Change in Total Cost Reduction = (-0.0466)(Year of Intervention) + 0.5069

5.4.1.4. Lemstra and Olszynski Data Extrapolation

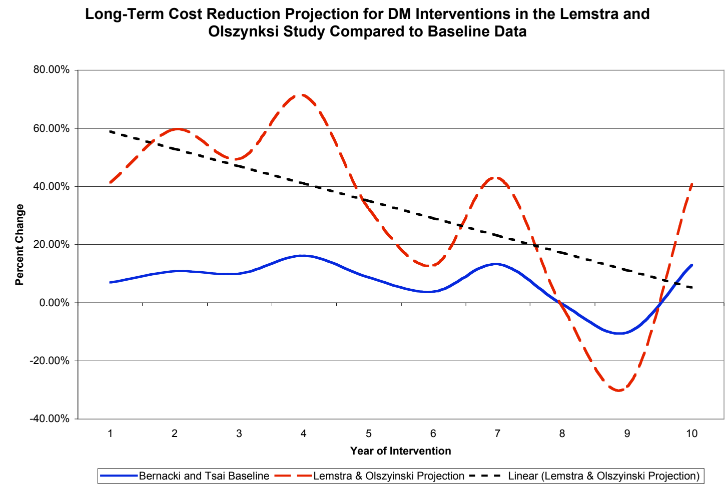
In this study, standard care was assessed against occupational medicine and early intervention (EI) in company A and EI is assessed against EI / occupational management in company B. EI was determined to be the most costly and had inferior health outcomes when compared to standard care or occupational medicine. This study reports on findings comparing EI against EI / occupational management in company B.

Three DM interventions were assessed in this study, one of which, physical therapist involvement, was deemed to be less rigorously applied as compared to the baseline study. Initial short-term savings were 41.3%. Projected long-term average per annum savings increased to 32.05% for the 10-year period, achieving a projected cumulative cost reduction of 320.53%. These cost reductions are high and are likely due to the two injury groups targeted (i.e., work-related upper extremity disorders and back pain), as these are known to be high service utilizers. Trend analysis using Microsoft Excel showed projected cost reductions over time beginning at about 58.96% in year one and decreasing to 5.22% at year 10.

Figure 14: Long-term extrapolation results for the Lemstra and Olszynksi study

Study by Lemstra and Olszynski

DM Intervention	Network / PPO	
	Occupational Med	
	Physical Therapist	◑
	Early Intervention	◑
	Guidelines	
	Treatment Planning	
	Ergonomic Asses	
	Accommodation	●
	Early RTW	●
% Reduction	Initial Short-Term Per Annum Change	**-41.30%**
	Projected Long-Term Mean Change Per Annum	**-32.05%**
	Projected Long-Term Cumulative Change	**-320.53%**



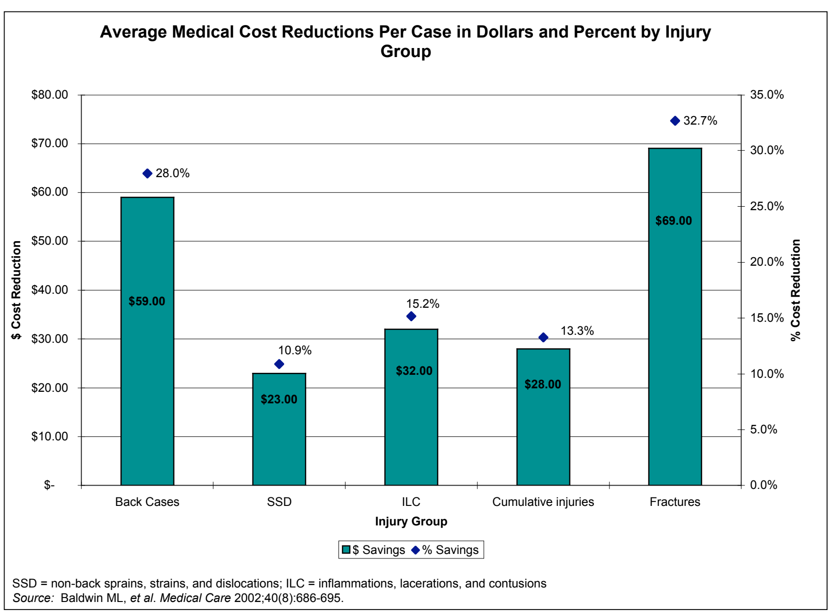
Linear % Change in Total Cost Reduction = (-0.0596)(Year of Intervention) + 0.6482

5.4.2. Part 2 – Cost Estimates Results

5.4.2.1. Cost Savings Based on Non-Lost Time Claims Using Baldwin et al. *Long-Term Projections*

In 2002, Baldwin *et al*. reported the effect that networks and associated DM activities had on reducing medical costs for select injury groups for claims of less than seven days. A key feature of this study was the allocation of the cost reduction to either the utilization or price component in which the authors identified whether a reduction in price (due to the network management) or reduced utilization (due to more structured care) was responsible for the decreased cost. The five injury groups assessed were: (1) back cases; (2) non-back sprains, strains, and dislocations; (3) inflammation, lacerations, and contusions; (4) cumulative injuries; and (5) fractures. Monetary and percentage cost reductions for each injury group are reported in Figure 15.

Figure 15: Average medical cost reductions per case in dollars and percent for the five injury groups assessed by Baldwin *et al*.



The five injury groups identified in Figure 15 (above) were used as the basis for classifying similar injury groups in the TWCC population. Information from diagnostic categories was used to classify injury groups as a back case, SSD, ILC, or fracture. Cumulative stress injuries were not identified in the TWCC population due to a lack of data from the original study in which to properly identify similar injuries in the TWCC population and are not compared to TWCC data. Table 64 details the diagnostic category codes used to classify TWCC data based on the above five injury groups.

Table 64: Diagnostic categories for back cases, SSD, ILC, fractures, and cumulative stress injuries for TWCC comparison

Original Injury Category	Diagnostic Category Code
Back cases	0402, 0501, 0502
SSD	0309, 0602, 0609, 0702, 0709, 0802, 0809, 0902, 1002, 1009, 1102, 1109, 2302, 9802
ILC	0107, 0108, 0111, 0207, 0208, 0607, 0608, 0707, 0807, 0808, 0811, 0907, 0908, 1007, 1107, 1108, 1700, 1720, 1797, 1907, 1908, 1998, 2307, 2508,, 3007, 9807, 9808
Fractures	0210, 0310, 0409, 0410, 0510, 0610, 0710, 0810, 0828, 1110, 1128, 1910, 1928, 2310
Cumulative stress injuries	Unable to classify based on information provided in the original study

SSD = Non-back sprains, strains, and dislocations; ILC = Inflammations, lacerations, and contusions
Note: Diagnostic categories are available in the Appendix

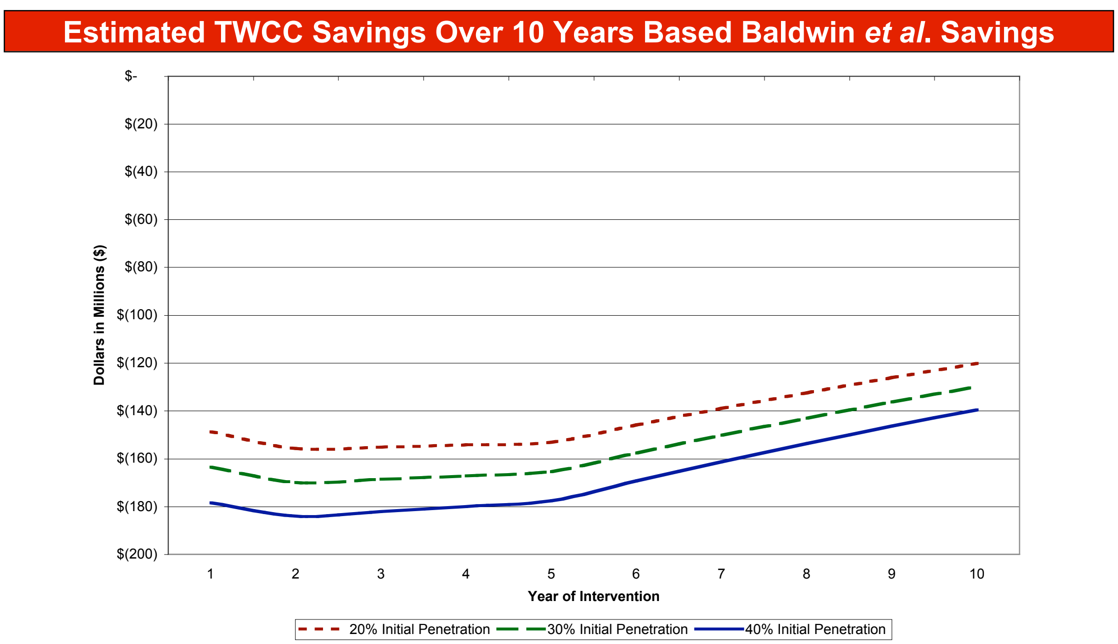
Table 65: Number of claims and mean cost per claim for TWCC back, SSD, ILC, fractures, and cumulative stress injuries with a claim length of less than seven days

Injury Type	N	Mean	S.D.	Total
Back cases	28,044	$1,439	$5,352	$40,347,744
SSD	23,788	$1,211	$3,689	$28,804,651
ILC	57,920	$ 584	$2,176	$33,847,869
Fractures	7,191	$1,708	$5,922	$12,284,098
Cumulative stress injuries	-	-	-	-
Total medical	116,943	$ 986	$3,475	$115,284,362

SSD = Non-back sprains, strains, and dislocations; ILC = Inflammations, lacerations, and contusion

Table 65 shows the number of injuries, mean cost, standard deviation, and total cost by injury type in the TWCC study population for claims of less than seven days in length. The mean claim cost of $986 ± $3,475 is slightly higher than the mean cost of $673 reported for non-network care by Baldwin *et al*. However, this difference is not unexpected due to the high penetration of managed care in two of the assessed states, California and Connecticut. Thus, while the comparison is between the TWCC population (i.e., non-network) and the non-network group in the Baldwin *et al*. study, the non-network group in Baldwin *et al*. is likely to be influenced by the availability of network care in those states. That is, just having network care in those states exerts a downward cost pressure on non-network care. Figure 16 identifies potential savings in the TWCC patient population based on input data and projected long-term cost reductions calculated from the Baldwin *et al*. study.

Figure 16: Potential savings in the TWCC population for injury treatment using injury groups in the Baldwin *et al*. study for claims of less than seven days



Estimated Per Annum Savings for Select WC Injuries Using TWCC Data from CY 2001 (in 2001 Dollars)										
Initial Penetration Rate	Year 1 Savings	Year 2 Savings	Year 3 Savings	Year 4 Savings	Year 5 Savings	Year 6 Savings	Year 7 Savings	Year 8 Savings	Year 9 Savings	Year 10 Savings
20%	($149M)	($156M)	($155M)	($115M)	($154M)	($153M)	($146M)	($132M)	($126M)	($120M)
30%	($163M)	($170M)	($169M)	($167M)	($165M)	($157M)	($150M)	($143M)	($136M)	($130M)
40%	($178M)	($184M)	($182M)	($180M)	($178M)	($169M)	($161M)	($154M)	($146M)	($139M)

* The number of TWCC injuries is the total number of injuries receiving both medical and indemnity benefits for a period of seven days or less based on the injury category(ies) identified by the comparison group in the peer-reviewed study.

This analysis calculated projected savings for specific injury group claims of less than seven days in length. However, as substantiated by this analysis, claims of less than seven days in length typically do not benefit from DM interventions – either at the initial 20%, 30% or 40% penetration level. In this case, DM interventions not only did not reduce expenditure, but increased net costs associated with these injury groups. That is, savings associated with DM interventions were more than offset by the cost of these interventions.

5.4.2.2. Cost Savings Based on Arnetz et al*. Long-Term Projections*

In 2003, Arnetz *et al*. reported medical and indemnity cost reductions of 21.44% after implementing a series of DM interventions to treat musculoskeletal disorders (MSDs).[161] The MSD injuries targeted in this intervention were based on diagnostic classifications listed on the sick leave certificate provided by the National Social Insurance Office. All MSDs related to the neck, shoulder, back, and joint, were included and symptom severity was determined by questionnaire.[162] Table 66 details the diagnostic category codes used to classify TWCC data based on the MSD injuries identified by Arnetz *et al*.

Table 66: Number of claims and mean medical cost per claim for TWCC MSD injuries with a claim length from 30 days to 2 years

Original Injury Category	Soft Tissue Injury	Superficial Trauma Injury	Skeletal Trauma Injury	Degenerative Disease Injury
Low Back	0500, 0501, 0502, 0506	0507, 0508	0509, 0510	0525, 0526
Thoracic spine	0401	-	0409, 0410	-
Shoulder	0601, 0602, 0603	0607, 0608	0609, 0610	-
Neck	0301, 0302, 0306	0308, 0309, 0310	-	0326
Joint	1900	-	-	1925

DC = Diagnostic category code provided by TWCC; diagnostic categories are available in the Appendix
A dash (-) indicates there was no corresponding diagnostic category

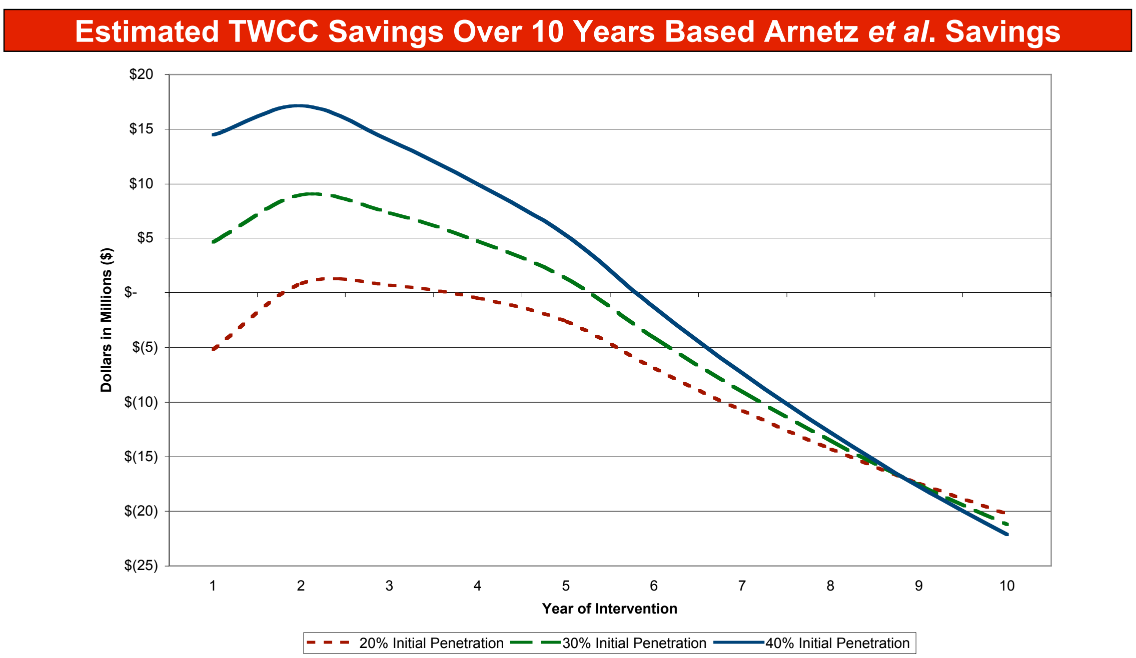
Table 67: Number of claims and mean cost per claim for TWCC MSD injuries with length of claim between 30 days and 2 years

Expense Type	N	Mean	S.D.	Total
Medical	18,034	$13,964	$18,453	$251,827,858
Indemnity	18,029	$9,748	$9,798	$175,744,348
Medical + Indemnity	18,034	$23,709	$24,225	$427,572,206

[161] Arnetz BB, Sjögren B, Rydèhn B and Meisel R. Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study. *Journal of Occupational and Environmental Medicine* 2003;45(5):499-506.
[162] Personal communication with Bengt B. Arnetz, MD, PhD., 10-8-04 by electronic mail.

Table 67 shows the number of injuries, mean cost, standard deviation, and total cost by expense type for MSD injuries in the TWCC study population with a claim length ranging from 1 month to 2 years. The total number of claims (i.e., medical plus indemnity) ranging in length from 1 month to 2 years was 18,034 with an average per case cost of $23,709 ± $24,225. The total spend between January 1 and December 31, 2001 for MSD injuries was approximately $427.6 million, of which 58.9% was due to medical costs and 41.1% was due to indemnity benefits. Figure 17 identifies potential savings in the TWCC population over a ten-year period.

Figure 17: Potential savings in the TWCC population for injury treatment using injury groups in the Arnetz *et al*. study for claims from 30 days to 2 years in length



Estimated Per Annum Savings for MSD Injuries Using TWCC Data from CY 2001 (in 2001 Dollars)										
Initial Penetration Rate	Year 1 Savings	Year 2 Savings	Year 3 Savings	Year 4 Savings	Year 5 Savings	Year 6 Savings	Year 7 Savings	Year 8 Savings	Year 9 Savings	Year 10 Savings
20%	($5.2M)	$.856M	$.719M	($.492M)	($2.6M)	($6.9M)	($10.8M)	($14.3M)	($17.4M)	($20.2M)
30%	$4.7M	$9.0M	$7.4M	$4.7M	$1.3M	($4.1M)	($9.1M)	($13.6M)	($17.6M)	($21.2M)
40%	$14.5M	$17.2M	$14.0M	$10.0M	$5.3M	($1.4M)	($7.4M)	($12.8M)	($17.7M)	($22.1M)

* The number of TWCC injuries is the total number of injuries receiving both medical and indemnity benefits for a period of least 1 month up to 2 years based on the injury category(ies) identified by the comparison group in the peer-reviewed study.

As seen in Figure 17, the ability of DM interventions to reduce costs is low and diminishing at the initial 20% penetration rate. At the 30% initial penetration rate, savings total savings of approximately $38.8 million are achieved during the first five years before treatment planning savings are offset by additional treatment planning costs. By year five, total penetration is assumed to have reached 55%. By year six in both the 30% and 40% initial penetration group, program costs offset any savings.

5.4.2.3. Cost Savings Based on Cheadle et al*. Long-Term Projections*

Managed care, along with specific DM interventions, was used as the primary strategy for improving early RTW and reducing costs associated with WC injuries by Cheadle *et al*. In this study, the authors report a 32.3% decrease in WC expenditure during a one-year period. All injuries during the one-year period were included. Table 68 shows the number of injuries, mean cost, standard deviation, and total cost by expense type for all injuries in the TWCC study population that had a length of claim ranging from 1 month to 2 years.

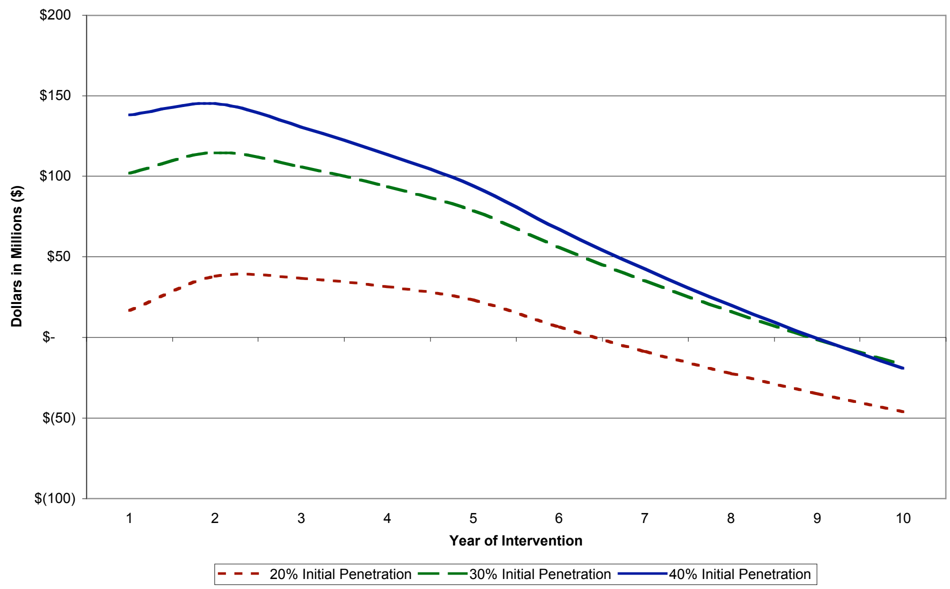
Table 68: Number of claims and mean cost per claim for all TWCC injuries with length of claim between 30 days and 2 years

Expense Type	N	Mean	S.D.	Total
Medical	44,625	$12,601	$18,641	$562,319,625
Indemnity	51,042	$8,526	$9,045	$435,176,946
Medical + Indemnity	51,055	$19,538	$22,957	$997,496,571

A total of 51,055 claims occurred between January 1 and December 31, 2001 that lasted between 1 month and 2 years. These claims had a mean cost per case of $19,538. In total, nearly $1 billion in combined medical and indemnity benefits was spent on these claims. Medical expenses represented 56.4% of medical service expenditure while indemnity claims represented 43.6%. Figure 18 identifies projected savings in the TWCC population over a ten-year period.

Figure 18: Potential savings in the TWCC population for injury treatment using injury groups in the Cheadle *et al*. study for claims from 30 days to 2 years in length

Estimated TWCC Savings Over 10 Years Based Cheadle *et al*. Savings



Estimated Per Annum Savings for All Injuries Using TWCC Data from CY 2001 (in 2001 Dollars)										
Initial Penetration Rate	Year 1 Savings	Year 2 Savings	Year 3 Savings	Year 4 Savings	Year 5 Savings	Year 6 Savings	Year 7 Savings	Year 8 Savings	Year 9 Savings	Year 10 Savings
20%	$16.6M	$37.9M	$36.5M	$31.4M	$23.1M	$6.35M	($8.82M)	($22.6M)	($35.0M)	($46.1M)
30%	$101.7M	$114.7M	$105.7M	$93.4M	$78.5M	$55.7M	$34.8M	$15.8M	($1.4M)	($17.0M)
40%	$138.1M	$145.2M	$130.7M	$113.4M	$93.9M	$66.9M	$42.2M	$19.7M	($.673M)	($19.2M)

* The number of TWCC injuries is the total number of injuries receiving both medical and indemnity benefits for a period of least 1 month up to 2 years based on the injury category(ies) identified by the comparison group in the peer-reviewed study.

At the initial 20% penetration rate, there is an estimated cumulative savings of $151.85 million associated with implementing DM interventions during the first six years. Much higher saving are achieved at the 30% and 40% initial penetration rates through year eight, although at a gradually decreasing rate. First year savings at the 40% penetration is estimated to be about $101 million while first year savings at the 40% penetration rate are estimated to be $138.1 million. Through year eight, total expected savings with initial 30% and 40% penetration rates are approximately $600 million and $750 million, respectively. By year nine, savings are no longer attained, primarily because the incidence of injuries is expected remain steady. As such, if injury incidence is not reduced over time, the sheer quantity of injuries, multiplied by per injury costs will eventually negate potential savings.

It should be noted that all injuries, regardless of type, were included in this analysis, and that the impact on individual injury groups cannot be determined. Yet, based on other analyses in this study, a targeted approach to high utilization injuries like low back regional pain may prove more cost-effective than a blanket approach.

5.4.2.4. Cost Savings Based on Lemstra and Olszynski Long-Term Projections

Lemstra and Olszynski studied the impact of occupational management[163] in a small Canadian firm to determine the impact on return to work and medical expenditure. During the one-year study period, they reported savings of 41.3% for the treatment of work-related upper extremity disorders (WRUED) and back cases. WRUED was defined "as any strain/sprain from the wrist joint to the shoulder joint [while] back injuries were defined as any strain/sprain of the lower (L_5) to mid back (T_6)" region.[164] Table 69 details the diagnostic category codes used to classify TWCC data based on WRUED injuries identified by Lemstra and Olszynski.

Table 69: Diagnostic categories for TWCC WRUED and back case comparisons

Original Injury Category	Soft Tissue Injury	Superficial Trauma Injury	Skeletal Trauma Injury	Degenerative Disease Injury
Low Back	0502	-	-	-
Thoracic spine	0402	-	-	-
Shoulder	0602	-	-	-
Elbow	0702	-	-	-
Hand / Wrist	0802	-	-	-

DC = Diagnostic category code provided by TWCC; diagnostic categories are available in the Appendix
A dash (-) indicates there was no corresponding diagnostic category

Table 70: Number of claims and mean cost per claim for TWCC WRUED injuries with length of claim between 30 days and 2 years

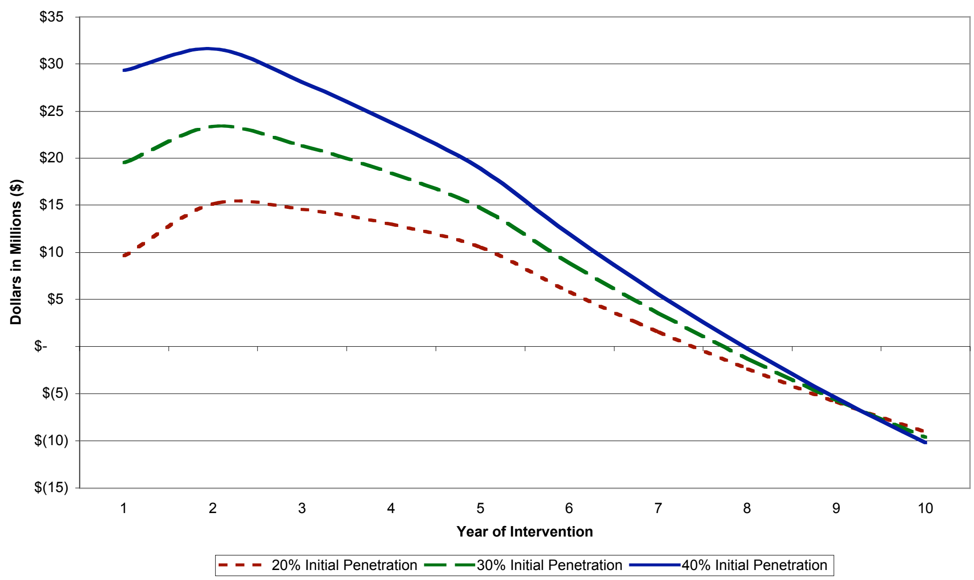
Expense Type	N	Mean	S.D.	Total
Medical	9,125	$13,884	$17,343	$126,693,508
Indemnity	9,121	$9,142	$9,232	$83,383,138
Medical + Indemnity	9,125	$23,022	$23,167	$210,076,646

[163] In this study, occupational management includes: minimal clinical intervention; reassurance of a good prognosis; education of the injury; encouragement to resume normal activities; self care and patient education; simple exercise programs; early RTW and modified work-duty; onsite assistance; program monitoring by the employer and union; etc.
[164] Lemstra M and Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in Workers' Compensation claims: part 2. *Spine* 2004;29(14):1573-1579.

Table 70 shows the number of injuries, mean cost, standard deviation, and total cost by expense type for WRUED and back injuries in the TWCC study population with a claim length ranging from 1 month to 2 years. There were 9,125 total claim payments with an average claim cost of $23,022 ± $23,167 for a total payment of just over $210 million. Figure 19 identifies projected savings in the TWCC population over a ten-year period.

Figure 19: Potential savings in the TWCC population for injury treatment using injury groups in the Lemstra and Olszynski study for claims from 30 days to 2 years in length

Estimated TWCC Savings Over 10 Years Based Lemstra & Olszynski Savings



Estimated Per Annum Savings for Select Injuries Using TWCC Data from CY 2001 (in 2001 Dollars)										
Initial Penetration Rate	Year 1 Savings	Year 2 Savings	Year 3 Savings	Year 4 Savings	Year 5 Savings	Year 6 Savings	Year 7 Savings	Year 8 Savings	Year 9 Savings	Year 10 Savings
20%	$9.6M	$15.2M	$14.6M	$13.0M	$10.5M	$5.8M	$1.5M	($2.3M)	($5.9M)	($9.1M)
30%	$19.5M	$23.4M	$21.4M	$18.4M	$14.7M	$8.9M	$3.6M	($1.3M)	($5.7M)	($9.6M)
40%	$29.3M	$31.6M	$28.1M	$23.8M	$18.9M	$11.9M	$5.6M	($.216M)	($5.5M)	($10.2M)

* The number of TWCC injuries is the total number of injuries receiving both medical and indemnity benefits for a period of least 1 month up to 2 years based on the injury category(ies) identified by the comparison group in the peer-reviewed study.

Implementing a DM program with an initial penetration rate of 20% for treating WRUED injuries is estimated to save approximately $70.2 million in the first seven years before reaching a constant penetration of 45%. DM programs that have an initial penetration rate of 30% and 40% achieved savings through year eight of the program. As expected, savings are higher overall for a program that achieves an initial 40% penetration with first year savings of approximately $29.3 million. By year seven, annual savings have diminished to about $5.6 million per year before becoming negative in year eight. As in the previous analyses by Arnetz *et al*. and Cheadle *et al*. the cost of providing DM activities will begin to outweigh potential savings by year eight for the initial penetration rates of 30% and 40% unless the number of WRUED and back injuries are reduced.

6. Discussion

6.1. Introduction

The purpose of this project was to identify and examine relationships between disability management practices, lost time, and system expenditures related to workers' compensation injury and disability. To accomplish this, three broad sets of statistical analyses were conducted using de-identified event-level data provided by the Texas Workers' Compensation Commission. This section provides a discussion of the results found in the: (1) bivariate analyses; (2) regression analyses; and (3) model to estimate the effects of disability management on cost and utilization.

6.2. Bivariate Analyses Discussion

Ten bivariate analyses were conducted to examine the relationships of selected independent variables with medical service utilization, expenditure, and time off from work. Dependent variables in the medical service utilization category included the number of visits to a physician's office, hospital, emergency department, or "elsewhere." Dependent variables in the expenditure category included expenses related to medical payment, lost time benefits, and total expenditure.

Because a large population was used in this study, a conservative p-value ($\alpha = 0.001$) was used for all tests to establish statistical significance. Despite this conservative threshold, the majority of bivariate analyses (i.e., greater than 95%) achieved statistical significance. Therefore, for discussion purposes, achieving statistical significance alone was not considered sufficient to draw meaningful conclusions about the results. As such, any result that reached statistical significance at $p < 0.001$ was also reviewed to determine if the results exhibited practical significance. Results that were both statistically and practically significant were further discussed.

6.2.1. Age

This analysis intended to determine what relationship, if any, existed between the age of a claimant and: (a) medical service utilization; (b) expenditure; and (c) time off from work due to injury. The Pearson's correlation statistical procedure was used to examine these relationships.

The relationships, while achieving statistical significance for all eight outcome variables at $p < 0.001$, were not practically significant. This is based on weak correlation coefficients associated with each of the eight analyses. For example, of the eight outcome variables assessed, the highest correlation coefficient achieved was 0.13 for the variable log of total expenditure. Generally speaking, a correlation coefficient less than 0.25 is considered to indicate a weak relationship between the variables.

The finding that age was only weakly associated with the outcome variable was somewhat surprising as age is typically a predictor of medical service utilization. For example, as the population ages, more healthcare resources are used. Age distribution comparisons between the workers' compensation population and the general medical utilization population were not identified in the literature; however, it is likely that the general medical service demographics of injured workers tend to be younger (due to the typical working age range of 18 – 65 years old) as compared to the general population, who typically use more medical services towards the end of life. In the workers' compensation population identified in this data, the relationships with age were not practically meaningful. Potential reasons for this could be that older age workers occupy less hazardous jobs than younger age workers or that older workers, while potentially suffering more general health problems, are not at a greater risk of suffering work-related injuries as compared to younger workers.

The lack of a strong association between age and the outcome variables is surprising. In a survival analysis using workers' compensation injuries as the study population, Cheadle *et al*. showed that after adjusting for other variables, older age predicted longer duration of disability.[165] Similar findings were noted by Feuerstein[166] and Kenny.[167] In the current analysis using TWCC data, age is weakly correlated (0.06) with number of weeks off work, although this did achieve statistical significance.

6.2.2. Gender

This analysis intended to determine what relationship, if any, existed between claimant gender and: (a) medical service utilization; (b) expenditure; and (c) time off from work

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[165] Cheadle A, Franklin G, Wolfhagen C, *et al.* Factors influencing the duration of work-related disability: a population-based study of Washington State workers' compensation. *American Journal of Public Health* 1994;84(2):190-196.
[166] Feuerstein M, Huang GD, Ortiz JM, *et al.* Integrated case management for work-related upper-extremity disorders: impact of patient satisfaction on health and work status. *Journal of Occupational and Environmental Medicine* 2003;45(8):803-812.
[167] Kenny D. Determinants of time lost from workplace injuries: the impact of the injury, the injured, the industry, the intervention and the insurer. *International Journal of Rehabilitation Research* 1994;17(4):333-42.

due to injury. The independent-samples T-test statistical procedure was used to examine these relationships.

The results achieved statistical significance at $p < 0.001$ for all dependent variables by gender except log of total expenditure ($p = 0.969$). This means that there were differences in medical utilization, expenditure, and time of work due to injury between men and women for seven of the eight variables.

Dependent variables that appeared to show practically meaningful differences between men and women were number of office visits, number of visits elsewhere, and number of weeks off work due to injury. For example, women had more office visits (17.70 vs. 14.53), had more visits "elsewhere" (85.50 vs. 74.61), and had more weeks off work due to injury (20.01 vs. 17.91) than men. Women also had slightly higher log medical payments than men (7.60 vs. 7.53), which is not surprising considering they had higher medical service utilization. This difference is of questionable practical significance. It is interesting to note that the non-transformed means for medical payments were higher for men ($7,843.69) than for women ($7,320.13), a relationship opposite of that seen for the log-transformed values. It is likely that this discrepancy occurred due to differences between men and women in the extent of skewness in the distributions of medical payments.

The results from this analysis conflict with published reports on gender differences with regard to disability duration. Two studies reported duration of disability by gender. One reported no difference in disability duration by gender as measured by the work rehabilitation impact quotient[168] while the second reported that women had less duration of time off as compared to men as measured by a hazard ratio of 0.85.[169] That is, women had a 15% longer duration of disability than men. In the TWCC study, women had a 10.5% longer duration of disability (as measured by time off work with benefits) than men.

6.2.3. Race

This analysis was not conducted.

6.2.4. Diagnosis

This analysis intended to determine what relationship, if any, existed between the top five diagnostic categories and: (a) medical service utilization; (b) expenditure; and (c) time off from work due to injury. The one-way analysis of variance (ANOVA) statistical procedure was used to examine these relationships. The top five diagnostic categories are discussed in section 5.1.8 of this report. The omnibus F-test was statistically significant at $p < 0.001$ for all dependent variables. Additional post-hoc analyses using the Scheffé post-hoc test were conducted to identify specific between-group differences.

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[168] Caradoc-Davies T and Hawker A. The work rehabilitation impact quotient: a tool to assess the effectiveness of early rehabilitation of injured workers. *Disability and Rehabilitation* 1996;18(12):613-618.
[169] Cheadle A, Franklin G, Wolfhagen C, *et al.* Factors influencing the duration of work-related disability: a population-based study of Washington State workers' compensation. *American Journal of Public Health* 1994;84(2):190-196.

Most of the post-hoc comparisons were statistically significant and some differences were deemed practically meaningful. When making judgments on post-hoc comparisons, it is important to consider the injury type. Outcomes are expected to differ by injury type since different injuries require different levels of care and attention. Since these top five categories represent disparate injury types, it is not unexpected that the outcomes differ among them. For example, it is reasonable to expect that a back injury would require more medical service utilization and have a higher medical expenditure than a wrist laceration. Yet, in terms of frequency of occurrence, both are included as top 5 injuries in this study. Therefore, discussions in this section deal with categories 1 and 3; both of which represent lower back injuries and are medically similar in nature. The reader is invited to consult complete post-hoc test results to identify differences between other categories.

Of the five diagnostic categories, only category 1 and 3 represent similar injury types (i.e., back injuries). Post-hoc comparisons between these two categories reveal potentially meaningful differences between the two categories. Category 3 patients have on average 0.58 more hospital visits than those in category 1 ($p < 0.001$). An additional half-day hospital stay, on average, would be expensive and may be indicative of inappropriate treatment. Likewise, total expenditure differed statistically between the two groups (log difference of 0.15; mean dollar value difference of $1,651.66; $p \leq 0.001$). This difference is also likely to be practically meaningful in terms of overall cost to the WC system.

In addition to mean differences between diagnostic categories, it is important to consider which diagnostic categories contribute to overall medical costs within the Texas WC system. By far, low back strain and sprain (category 502) represents the largest total medical expenditure to the Texas system. During this study time period, \$133.5 million, or 13.6% of the total medical expenditure, was spent on category 502 claims representing 10.6% of total injuries reported. Relatively speaking, the mean cost of \$4,984 is not the highest mean cost, but is in the top five. Rather, utilization is highest for this diagnostic group, with some 26,807 claims. The second largest medical expenditure category was low back regional pain at \$61.67 million followed by shoulder strain / sprain at \$47.1 million. Clearly, major cost drivers within the TWCC system related to soft injury sprains and strains to the back and shoulder region.

6.2.5. CPT-4 Code

This analysis was not conducted.

6.2.6. Comorbidity

This analysis was not conducted.

6.2.7. Claimant Location

This analysis was not conducted

6.2.8. Pre-Injury Wage

This analysis intended to determine what relationship, if any, existed between the claimant's log of pre-injury wage and: (a) medical service utilization; (b) expenditure; and (c) time off from work due to injury. The Pearson's correlation statistical procedure was used to examine these relationships.

Six of the eight analyses achieved statistical significance at $p < 0.001$. The only two dependent variables that did not achieve statistical significance were number of ED visits and number of visits elsewhere at $p = 0.007$ and $p = 0.310$, respectively. As for practical significance, correlation coefficients ranged from –0.03 to 0.25, with the two highest correlation coefficients being log of total medical expenditure (0.18) and log of lost time benefit (0.25). Like the correlation coefficients associated with age, those associated with pre-injury wage are only weakly associated with the outcome variable.

The findings from this analysis are somewhat surprising as pre-injury wage would have been expected to be more strongly correlated with use of medical services, and hence expenditure and time off, among WC claimants. Yet, this was not supported by the Pearson correlation results. One likely reason is that slightly less than half of WC claimants had a pre-injury wage reported (N=77,090; 47.1%). Likewise, because of the nature of this database, the carrier may not have reported all pre-injury wages.

6.2.9. Number of Office Visits

This analysis intended to determine what relationship, if any, existed between the number of office visits made for a particular claim and: (a) medical expenditure; and (b) time off from work due to injury. The Pearson's correlation statistical procedure was used to examine these relationships.

The relationships between all four dependent variables and number of office visits were statistically significant at $p < 0.001$. In addition, all four dependent variables had correlation coefficients that are moderate in strength and positive in direction. In the medical expenditure category, log of medical payments exhibited the highest correlation (0.54), followed by log of total medical expenditure (0.53), and log of lost time benefits (0.34). The number of weeks off work due to injury was moderately correlated to the number of office visits at 0.40. These results suggest that higher medical service utilization as expressed by number of office visits is correlated with increased expenditure and increased time off work due to injury. These findings were not unexpected.

The number of visits per injured worker were assessed in several studies. However, these studies were making comparisons in the number of visits before and after managed care was implemented. Therefore, these findings, while interesting, are not directly applicable to the results of hypothesis 9.

6.2.10. Time Off Work Due to Injury

This hypothesis intended to determine what relationship, if any, existed between time off work for an injury and: (a) medical service utilization; and (b) expenditure. The Pearson's correlation statistical procedure was used to examine these relationships.

All seven analyses achieved statistical significance at $p < 0.001$. In terms of practical significance, one variable had a weak correlation coefficient, three had moderate correlation coefficients, and two had strong correlation coefficients. The weakest correlation coefficient was 0.07 and was for the variable number of ED visits. Moderate correlation coefficients were found for number of hospital visits (0.30), number of office visits (0.40), number of visits elsewhere (0.41), and log of medical payment (0.45). Log of total expenditure and log of lost time benefits exhibited the strongest correlation coefficients at 0.62 and 0.72, respectively.

These moderate to high correlations were all positive in direction and show a relationship between time off work due to injury and medical service utilization and medical expenditure. This is not surprising since time off work would reasonably be thought to show a relationship with medical utilization and expenditure. For example, the longer a claimant is off work, the greater the use of medical services and associated costs. Likewise, being off work impacts the number of weeks that lost time benefits are received. The strong correlation between number of weeks off work due to injury and log of lost time benefits (0.72) supports this conclusion.

6.2.11. Pre-Injury Hours Worked

This analysis was not conducted

6.2.12. Physician Practice Type

This analysis was not conducted

6.2.13. Physician Specialty

This analysis was not conducted

6.2.14. Location of Initial Visit

This analysis intended to determine what relationship, if any, existed between the location of initial visit and: (a) expenditure; and (b) time off from work due to injury. The one-way analysis of variance (ANOVA) statistical procedure was used to examine these relationships. The three locations of initial visit were the emergency department (ED), physician's office, or office visit to another practitioner.

The omnibus F-test for all dependent variables was statistically significant at $p < 0.001$. Additional post-hoc analyses using the Scheffé post-hoc test were conducted to identify which specific comparisons were statistically significant. Three of the post-hoc tests for the dependent variable time off from work due to injury were deemed to be both statistically and practically significant.

The amount of time off work varied practically and statistically based on the location of initial visit. For example, claimants who first sought help by visiting an emergency department had an average of 1.35 fewer weeks off work than a claimant who first sought care by visiting a physician in his or her office. Likewise, claimants visiting the emergency department as the location of initial visit had 2.45 fewer weeks off than those who visited “other” offices. Similarly, those seeking assistance at a physician’s office in the first instance had, on average, 1.09 fewer weeks off work due to injury than someone who visited an “other” office first.

These results are somewhat surprising. For example, the fact that claimants treated in the emergency department (ED) had fewer weeks off than claimants who were first treated in a physician’s office seems counter-intuitive. Possible explanations for these results include more immediate treatment at the ED. That is, an injured worker who receives care at an ED is likely to receive care within 24 hours of appearing at the ED. This same injured claimant may have to wait several days to book an appointment, receive treatment, and then be referred to follow-up care if the claimant goes to his regular doctor. Likewise, ED treatment may be for more acute problems whereas an office visit may be for more chronic injuries (e.g., lower back pain), thus requiring multiple treatment visits. Unfortunately, the quantitative nature of this database does not provide information on the severity of each visit.

Another interesting finding is that a claimant who seeks treatment at a physician's office in the first instance has more time off than someone whose initial care visit is "elsewhere" (e.g., optometrist, chiropractor, occupational / physical therapist). Potential reasons for this may be a claimant's desire to seek specific care (e.g., from a chiropractor) initially. Secondly, patients who tend to visit a physician first may have more chronic conditions that require care on a long-term basis.

6.2.15. Provider Type and Medical Payment

This analysis intended to determine what relationship, if any, existed between practitioner type and medical expenditure. The one-way analysis of variance (ANOVA) and repeated measures ANOVA procedures were used to examine these relationships. The eight providers were classified as: (1) medical doctor; (2) doctor of osteopathy; (3) physician's assistant; (4) doctor of chiropractic; (5) physical therapist; (6) occupational therapist; (7) doctor of optometry; (8) and other providers.

The omnibus F-test for all dependent variables was statistically significant at $p < 0.001$. Additional post-hoc analyses using the Scheffé post-hoc test were conducted to identify which specific comparisons were statistically significant. Several of the post-hoc tests for the dependent variable medical payment were deemed to be both statistically and practically significant.

The amount of medical expenditure varied by type of practitioner providing care. Some of the differences, although statistically significant, are expected. For example, care provided by a physician (either allopathic or osteopathic) would be expected to cost more than care provided by a physician's assistant. This is because physician assistants typically can bill for only 80% of what a physician can bill for the same procedure. Other differences, however, appear to be practically meaningful. Based on the claims-level analysis, the cost for chiropractic care is higher than the cost for each of the seven other practitioner types. When compared to allopathic physicians (MD), chiropractic care costs on average $3,253,62 more; however, less utilization occurred for chiropractic care (34,006 chiropractic claims vs. 231,641 MD claims). When compared to osteopathic care (DO), chiropractors have a higher average cost of $39,75.99, again with less utilization (34,006 chiropractic claims vs. 45,595 DO claims). It should be noted that because of less utilization of chiropractic care in relation to MD care, system-wide means for chiropractic care are lower as a result of adding a payment value of $0 in the repeated measures ANOVA for all claims in which chiropractic care did not occur. Because there more instances of "no care" by chiropractors vs. "no care" by allopathic physicians, mean medical payments for chiropractors are much lower than those for physicians.

6.2.16. TWCC Region of Service

This analysis intended to determine what relationship, if any, existed between the TWCC location in which the claim is handled and: (a) medical service utilization; (b) expenditure; and (c) time off from work due to injury. The one-way analysis of variance (ANOVA) statistical procedure was used to examine these relationships. The four TWCC services regions are: (1) Dallas / Ft. Worth; (2) Houston / Galveston; (3) Austin / San Antonio; and (4) El Paso / Lubbock / and San Angelo.

The omnibus F-test for all dependent variables achieved statistical significance at $p < 0.001$. Additional post-hoc analyses using the Scheffé post-hoc test were conducted to identify which specific comparisons were statistically significant.

There were clear differences in service utilization for office visits and “other” visits across TWCC regions. For example, claimants in region 1 had 6.50 more office visits than those in region 3 and 10.26 more than those in region 4. Claimants in region 2 had 4.90 and 8.66 more office visits than those in regions 3 and 4, respectively. Claimants in region 3 had more office visits than those in region 4 (3.77). Regions 1, 2, and 3 reported even more “other” visits than those in region 4. For example, region 1 claimants could expect 29.66 and 48.68 “other” visits than claimants in regions 3 and, respectively. Region 2 claimants had 38.38 more “other” visits than those in region 3 and 57.40 more than those in region 4. Region 3 had 19.02 more “other” visits than those in region 4.

These findings are unexpected in magnitude, but not in scope. That is, it is expected that there will be geographic variations in medical service utilization, but the magnitude of the differences is unexpected. There are probably many reasons for the variation, but four immediately come to mind: (1) access; (2) concentration of medical services; (3) a rural vs. urban divide; and (4) injury type.

Region 1 includes Dallas and Fort Worth and region 2 primarily includes Houston. Both regions have a high concentration of medical practitioners, medical facilities, and teaching institutions. Likewise both regions are densely population with a well-developed transportation infrastructure. All of these factors point to an increase in utilization. Likewise, region 3, which includes the Austin – San Antonio corridor has a well-developed transportation infrastructure, high quality medical facilities, and one of the state's major teaching hospitals and medical institutions. Region 4, on the other hand, includes a large and diverse geographical area stretching from San Angelo and Lubbock to El Paso and the Rio Grande Valley. There is only one major medical institution in this region (Texas Tech Medical Center in Lubbock) and residents in this region have a relatively low socio-economic status. Therefore, claimants in regions 1 and 2 are likely to have better access to medical care and have a larger and more sophisticated set of medical services available and practitioners to choose from.

The results of this analysis are not surprising. That is, variations in care are expected across geographical regions – both intrastate and interstate. Two studies in the peer-reviewed literature specifically assessed geography with regard to workers' compensation care. One study reviewed the geographic variation in expenditure for hospitalized claims and the other reviewed the geographic variation in expenditure for physician claims.[170,171] These studies revealed considerable variation in both hospitalization expenditure and physician claim expenditure across states; interstate variations were not assessed. Despite the fact that interstate variations were not assessed, the conclusion from these articles is applicable to Texas: "Efforts should be directed at those areas that have higher

[170] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation physician claims *American Journal of Industrial Medicine* 1997;32(1):27-34.
[171] Miller TR and Levy D. Geographic variation in expenditures for Workers' Compensation hospitalized claims. *American Journal of Industrial Medicine* 1999;35(2):103-111.

costs without sufficient input price, quality, or case mix justification."[172] With regard to Texas, the extreme variations between Dallas / Ft. Worth and Houston / Galveston and the El Paso / West Texas service region should be assessed to determine if there are justifiable reasons for the differences in expenditure and medical service utilization.

In terms of rural vs. urban centers in the state of Texas, the Dallas / Ft. Worth region and the Houston / Galveston region, represent major urban centers of the state. Austin / San Antonio, represent a mix of both urban and rural. West Texas, is largely rural. Therefore, it is not surprising that there are differences between West Texas and other parts of the state. Again, though, this may be a reflection of accessibility and availability of services. Likewise, employers in urban areas may be more likely to opt in to workers' compensation than employers in rural areas. If this is the case, penetration of workers' compensation utilization may explain much of the variation of services across the four regions.

The fourth consideration is injury type. Although not addressed in the bivariate analyses, injury type could differ significantly between geographic regions. For example, West Texas day laborers may suffer more from acute injuries associated with migrant injuries while urban areas may suffer more chronic injuries associated.

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[172] *Ibid.*

6.2.17. Physician Specialization

This analysis was not conducted

6.2.18. Carriers

This analysis determined the relationship between the top 5 carriers and: (a) medical service utilization; (b) expenditure; and (c) lost time. The one-way analysis of variance (ANOVA) statistical procedure was used to examine these relationships.

The omnibus F-test was significant at $p < 0.001$ for the medical service utilization variables, log of benefit payment, log of total expenditure, and number of weeks of work due to injury. The omnibus F-test was not significant for log of medical payment ($p = 0.17$). Additional post-hoc analyses using the Scheffé post-hoc test were conducted to identify specific between-group differences.

The post-hoc tests indicate statistically as well as practically meaningful differences in some of the comparisons. For example, mean differences in office visits greater than one day may indicate potential medical practice variation in care delivery (e.g., one carrier may encourage use of treatment guidelines while another leaves treatment options to the physician). Claimants served by carrier 3 consistently utilize more office care than the other four carriers. The lack of qualitative data, however, does not allow us to infer whether this additional utilization is beneficial or harmful. Carrier 3 may have better outcomes as a result of having more office visit utilization. Likewise, carrier 3 may have a higher medical severity index for its patients. Hospital visits also were statistically different among most of the top five carriers, but the largest mean difference was only 0.38 visits (between carriers 1 and 4).

The number of weeks off work varied between carrier, but only carrier 4 claimants had statistically significantly more number of weeks off work than the other groups. Claimants managed by carrier 4 had over four weeks more off work than those managed by carriers 1 and 2, more than three weeks off than those managed by carrier 5, and more than two weeks off than those managed by carrier 3.

6.2.19. Unemployment

This analysis was not conducted

6.3. Discussion of Regression Results

Eight regression analyses were conducted to identify the predictive value of the five TWCC databases used in this study to estimate likely medical service utilization, expenditure, and time off from work for TWCC claimants.

6.3.1. <u>Predicting Number of Office Visits Using TWCC Data</u>

Despite achieving statistical significance, the overall predictive value of the 19 independent variables is very low. Indeed, 93% of the variance remains unexplained. Interestingly, of the top four predictors three included a TWCC region in which treatment occurred. Holding all other values constant, claimants treated in Dallas, Houston, and Austin / San Antonio had 15.78, 14.47, and 9.32 more office visits, respectively, than claimants treated in the reference group of El Paso / West Texas. These results are not surprising since bivariate analyses indicated that medical service utilization is highest in these three regions.

Another interesting finding is that some diagnostic groupers predict less medical service utilization holding all other values constant. For example, claimants with a hand / wrist laceration (808) can expect to have 9.41 fewer office visits than reference group injuries (i.e., diagnostic categories that do not fall within the top-ten injury groups). In addition, claimants who visit the emergency department can expect to have 2.83 fewer visits than claimants in the reference group (i.e., claimants who had neither a MD office nor ED visit).

6.3.2. Predicting Number of Hospitalizations Using TWCC Data

The 14 independent variables that best correlated with the dependent variable "number of hospitalizations" had a cumulative R^2 value of 0.049. Despite achieving statistical significance, the overall predictive value of these independent variables is very low and they are not good predictors of hospitalizations.

Holding all other variables constant, patients with an ED visit had 1.83 more hospitalizations compared to the reference group (i.e., claimants who had neither a MD office nor ED visit). In addition, TWCC claimants in Dallas, Houston, and Austin / San Antonio had more hospitalizations than claimants in the reference group of El Paso / West Texas with 0.45, 0.38, and 0.28 more hospitalizations, respectively. Only three variables (302, 802, and 1102) exhibited a negative relationship with the outcome variable with coefficient values of –0.32, -3.30, -0.78, respectively. Variable 802 (hand / wrist strain or sprain) had 3.30 fewer hospitalizations than the reference group (i.e., diagnostic categories that do not fall within the top-ten injury groups).

Several studies discussed influences on medical costs in workers compensation. However, these studies tend to compare costs before and after an intervention has been put in place. This contrasts with this analysis, which seeks to find predictors of medical expenditure in the TWCC population.

6.3.3. Predicting Number of ED Visits Using TWCC Data

Despite achieving statistical significance, the overall predictive value of the independent variables is very low with 96.9% of the variance for ED visits unexplained. Of the 12 variables identified as significantly associated with predicting an ED visit, six were specific diagnostic categories and seven had a negative association with the predictor variable. In addition, female claimants tended to have fewer ED visits than men (*B*: -0.60) holding all other variables constant. Claimants who made a visit to the ED had 0.26 fewer MD office visits, holding all other variables constant.

6.3.4. Predicting Number of "Other" Visits Using TWCC Data

As in the previous regression analyses, this analysis achieved statistical significance, yet the overall predictive value of the 16 independent variables is very low (5.9%). The top two variables in the model were regions in which the claim was treated. For example, holding all other variables constant, TWCC claimants in Dallas, Houston, and Austin / San Antonio had more "other" visits than claimants in the reference group of El Paso / West Texas with 71.66, 83.25, and 41.89 more "other" visits, respectively. Interestingly, there was variation in medical service utilization by carrier group. Claimants using carrier 1 had 46.25 more visits to "other" practitioners vs. the reference group (i.e., carriers not in the top-five for claims) while claimants using carrier 2 had 20.33 more "other" visits than the reference group (i.e., carriers not in the top-five for claims). The finding that carrier groups 1 and 2 predicting variables in this model is interesting since there is no known reason to expect that there should be any difference in medical service utilization by carrier group. No information on carrier groups besides cost and injury data (e.g., member characteristics, regions of service, etc.) were available.

6.3.5. Predicting Log of Medical Payment Using TWCC Data

Holding all other variables constant, the region in which treatment occurred is the largest predictor of log of medical payment with coefficient values of 0.68, 0.71, and 0.51 for Dallas, Houston, and Austin / San Antonio, respectively. The finding that the MD variable is negatively associated with the log of medical payment (B = -0.15) is interesting and unexpected. In fact, it is expected that an MD visit would contribute to the cost of medical services. However, it could be that the proper use of a physician visit could prevent long-term costly injuries from occurring or it could prevent use of costly services such as chiropractic care, which were shown in the bivariate analyses to be significantly more expensive than physician services (see section 5.2.9). In terms of specific diagnostic conditions, four were negatively associated with log of medical payment (1102 at – 0.68; 808 at –0.49; 807 at –0.40; and 810 at –0.19) and four were positively associated with log of medical payment (602 at 0.38; 302 at 0.29; 502 at 0.13; 1004 at 0.25), holding all other variables constant.

6.3.6. Predicting the Log of Indemnity Payment Using TWCC Data

Results from this exploratory analysis indicated that 16 independent variables were significant predictors of the dependent variable “log of indemnity payment” using the stepwise method ($p < 0.001$). Yet, despite achieving statistical significance, the overall predictive value of these 16 independent variables is very low. Holding all other variables constant, the pre-injury wage (*B* = 0.76) for the injured worker is the strongest predictor of indemnity payment in this model; this is not surprising since benefit payments are primarily based on pre-injury wage. The TWCC region of claim for Dallas, Houston, and Austin / San Antonio are also significant predictors in this model of indemnity payment with coefficients of 0.63, 0.71, and 0.57, respectively when compared to the reference group of El Paso / West Texas and when all other variables are held constant. Only three variables, 808, 1102, and 807 had a negative association with "log of indemnity payment" with coefficients of –0.58, -0.43, and –0.27, respectively when compared to the reference group (i.e., diagnostic categories that do not fall within the top-ten injury groups) and when all other variables were held constant.

6.3.7. Predicting the Log of Total Payment Using TWCC Data

Despite achieving statistical significance, the overall predictive value of these 20 independent variables is very low. Not surprisingly, wage, Dallas, Houston, and Austin / San Antonio remained the top predictors in this model for log of total payment (*B* = 0.54, 0.71, and 0.76, respectively). When compared to the reference group (i.e., diagnostic categories that do not fall within the top-ten injury groups), only two variables (808 and 1102) had a negative association with the log of total payment (*B* = -0.33 and –0.28, respectively).

6.3.8. Predicting the Number of Weeks off Work Using TWCC Data

Despite achieving statistical significance, the overall predictive value of the 18 independent variables is very low. Yet, there is great variability in the number of weeks off work predicted by the different variables. As in previous regression analyses, the TWCC region of treatment was a significant predictor of time off from work in this model. Holding other variables constant, workers had 11.40 more weeks off in Houston, 7.67 more weeks off in Dallas, and 8.19 more weeks off in Austin / San Antonio than workers in the reference group of El Paso / West Texas. Therefore, the TWCC region in which treatment occurs is also a predictor of time off when compared to the reference group of El Paso / West Texas. The type and severity of injury may explain differences in time off by region, but the most likely explanation is access to medical care, which in turn influences times off work (i.e., increases time off work). That is, injured workers in Dallas / Ft. Worth have greater access to different medical specialties as well as an overall large quantity of providers.

Variables that have a negative association with time off work include workers with hand / wrist lacerations, abrasions, contusions, or fracture (807, 808, and 810) and ankle / foot sprain or strain (1102) as compared to the reference group (i.e., diagnostic categories that do not fall within the top-ten injury groups). In addition, there is a large variation in the association between diagnostic category and time off work, ranging from –9.12 to 5.92 weeks off when compared to the reference group and when holding other variables constant.

6.4. *Discussion of Cost Estimation Models*

The cost estimation models constructed in this study include a long-term extrapolation component and a sensitivity analysis component, both of which are discussed below. As an overview, the cost estimation models seek to approximate potential savings over a 10-year period. However, there is uncertainty regarding estimated savings over the length of the estimation period. The long-term estimates seek to provide information on trends, yet the absolute value of the cost reduction or the exact time when disability management benefits begin to be offset by program costs are unknown. Specifically, the ability to provide reasonable long-term estimates is related to several factors, including: (1) the incidence and prevalence of injuries over time; (2) the emergence of new technologies; (3) the ability of medical inflation to stay within expected estimates; and (4) factors influencing the appropriate use of disability management.

6.4.1. Long-Term Extrapolation Component

The ability to estimate long-term trends after DM interventions are implemented is an important factor in determining whether DM is an appropriate and cost effective tool. Unfortunately, there is only one study in the peer-reviewed literature that details long-term results of implementing a DM program. To better help policy makers determine the appropriateness of implementing a DM system, additional results from different settings would be useful. There are some additional studies available, but these only assess DM interventions on a short-term basis.

A method to extrapolate long-term savings from short-term studies was created for this dissertation in order to estimate potential costs and results of implementing DM interventions. This method, as described earlier, allowed for the estimation of long-term savings to be calculated for four additional DM settings identified in the short-term results (i.e., with different injury types, interventions, geographic location of study). Each of these long-term extrapolations produced initial high savings that diminished over time. However, these extrapolations do not include providers who may identify methods to keep reimbursement high, despite methods to ensure savings. This section discusses some of the implications of these findings.

6.4.1.1. Long-Term Extrapolations Using the Arnetz et al. Data

Projected long-term results are consistent with expected findings of diminished, but continuing cost reductions over time. The cost reductions identified in this analysis are "middle of the road," and provide a good representation of likely cost reductions over time. Inclusion criteria for this study were not limited to particular claim lengths or injury types. Interestingly, this study is the only one that explicitly identified intervention costs. These costs represented 45.9% of the cost reduction. Intervention costs were not included in the short- and long-term calculations since these costs were considered when cost savings were estimated.

6.4.1.2. Long-Term Extrapolations Using the Baldwin et al. Data

As in the previous study, projected long-term results are consistent with expected findings of diminished, but continuing cost reductions over time. The cost reductions identified in this analysis are conservative, and may not represent total potential savings in the short- and long-term. The reason is because this study assessed only medical claims of less than seven days in length. It did not include potential savings occurring for indemnity benefits or long-term medical costs.

6.4.1.3. Long-Term Extrapolations Using the Cheadle et al. Data

Again, long-term results are consistent with expected findings of diminished, but continuing cost reductions over time. The cost reductions identified in this analysis are "middle of the road," and provide a good representation of likely cost reductions over time. In addition, the setting used by Cheadle *et al*. is likely to be representative of conditions that would be found in Texas; thus, these projections should be considered as a *potential* indicator of projected long-term cost reductions to be found in Texas. That is, of the four studies reviewed, only the Cheadle *et al*. setting represented a U.S. state workers' compensation system; the others represented specific injury types, specific industries, or occurred outside of the United States. This said, Washington State does differ from Texas in how it approaches social issues and its infrastructure with regard to monitoring workers' compensation claims and injuries.

6.4.1.4. Long-Term Extrapolations Using the Lemstra and Olszynski Data

Long-term results are consistent with expected findings of diminished, but continuing cost reductions over time. The cost reductions identified in this analysis are high and are unlikely to be attained for all conditions; however, the conditions assessed are major cost drivers for WC costs. Because there is excessive resource utilization for these conditions (i.e., soft tissue injuries), significant cost reductions may be possible.

6.4.2. Sensitivity Analysis Component

The sensitivity analysis component compared estimated costs of using a DM treatment planning approach at different levels of penetration versus usual care. Cost estimates included initial costs (based on TWCC data), costs of implementing a DM system, and potential savings. A sensitivity analysis was used to estimate the impact of DM penetration on cost (using initial penetration rates of 20%, 30%, and 40%, that increased by 10% in year 2 and by 5% in years 3 – 5 and holding steady thereafter). Annual percent savings were based on the linear cost reduction trends identified in the first component. A discussion of the findings is presented below.

6.4.2.1. Long-Term Extrapolations Using the Baldwin et al. Data

Implementing DM interventions targeted at claims of less than seven days does not save money, and in fact, costs more to implement than it saves. DM interventions should be targeted at claims between 30 days and two years in length. Claims of less than 30 days should not be targeted for DM interventions. Therefore, this study, while informative, is not relevant to this current study, which deals with long-term claim costs.

6.4.2.2. Long-Term Extrapolations Using the Arnetz et al. Data

The DM interventions used by Arnetz *et al*. have the potential to reduce costs associated with work-related musculoskeletal injuries that do not resolve within 30 days of injury in the TWCC population. Estimated savings are likely for the first five years of a program with both a 30% and 40% initial penetration rate. After year five, prevention activities should be championed as a way to attain further savings or increased penetration should be achieved.

6.4.2.3. Long-Term Extrapolations Using the Cheadle et al. Data

Projected cumulative savings of $750 million are possible over an eight-year period if DM interventions similar to those implemented by Cheadle *et al*. are implemented in the Texas workers' compensation system with an initial 40% penetration rate. Interventions targeted at specific injury groups may provide better results than using a blanket approach. Savings are projected for all initial penetration rates until at least year six.

6.4.2.4. Long-Term Extrapolations Using the Lemstra and Olszynski Data

Projected cumulative savings range from approximately $70 million to $149 million dollars are possible over a seven-year period if DM interventions are implemented in the Texas workers' compensation system at an initial penetration rate of 20%, 30%, or 40%.

At the 30% initial penetration level, projected savings during the first six years are \$109 million. In addition, the injury group associated with these savings, soft-tissue claims, are the highest cost driver for TWCC and thus, are most likely to experience the greatest cost savings after DM interventions and treatment planning are introduced.

6.5. Discussion Summary

6.5.1. Introduction

The purpose of this study was to identify and examine relationships between disability management practices, lost time, and system expenditures related to workers' compensation injury and disability. Specifically, it sought to: (1) identify factors contributing to prolonged disability within the Texas Workers' Compensation system; (2) identify time loss and disability management programs in other settings; and (3) develop a disability management model that could estimate the effect of time loss and disability management programs on work loss and health care utilization and expenditures. In doing so, this study aimed to assist efforts by TWCC to address rising utilization and expenditures, to improve the efficiency of health service provision by providers, and encourage timely return to work for injured workers. In order to develop a method to estimate the impact of DM, three broad sets of statistical analyses were undertaken using data provided by TWCC and the peer-reviewed literature.

(1) Bivariate analyses: In this stage, statistical tests were conducted to determine if statistical and practical relationships existed between independent variables (e.g., age, diagnoses, weekly wage) and dependent variables (e.g., medical service utilization, expenditure, and time off work). The results of these bivariate analyses were then used to determine inclusion variables for the regression analyses. Both statistical and practical significance were used to identify inclusion variables for the regression analyses.

(2) Regression analyses to estimate current outcomes in the TWCC system: In this stage, results from the bivariate analyses in (1) were used to build regression models to estimate the likely expenditure, service utilization, and time off work based on claimant characteristics.

(3) Disability management estimation model: In this stage, results from the previous two analyses were used to help determine the effect of DM on utilization, expenditures, and time off in the TWCC system. This model included a range of possible outcomes based on results identified in other settings using DM. Initial set-up and on-going DM program costs were considered in this model. The peer-reviewed literature was used to provide examples of expenditure control achievable by implementing a DM system. Sensitivity analyses based on DM penetration rates were used to identify optimal implementation strategies.

6.5.2. Implications

The implications of this research are several-fold:

(1) A comprehensive review of disability management practices to date provides a readily available source of information on different DM strategies, practices, and outcomes. This information will be useful to policy makers as they seek out alternative solutions to improving care for injured workers and for setting policy regarding DM interventions.

(2) Descriptive and inferential results provide a snapshot of the current state of affairs with regard to WC care in the state of Texas for the year 2001. In particular, the bivariate results indicate statistically significant relationships between most outcome variables and the assessed independent variables. However, most of these results are not practically meaningful. Yet, they do provide evidence of potential areas of concern within the system. For example, chiropractic care is a main cost driver of expenditures in the Texas system as compared to other healthcare providers.

Likewise, information from these analyses provides potential new information on utilization and costs. For example, injuries first treated in the emergency department have a higher overall mean cost per case than injuries treated in a physician's office. Yet, surprisingly, cases first treated "elsewhere" have a lower mean cost per case than those treated in a physician's office. The reason for this is unknown, but may reflect better use of resources (i.e., getting the right care at the right time from the right provider). Qualitative exploration could find answers to some of these questions. In addition, economic outcomes by provider type, region of service, etc., may be disorder specific.

(3) The cost estimation model can provide useful information to TWCC on estimated costs and benefits of implementing a DM program in Texas. This model, while dependent on several assumptions, provides a good starting

point for estimating savings associated with providing DM services. This model also showed the effect of implementing DM at a variety of penetration rates (i.e., to what extent is the patient population covered by DM services). Not surprisingly, at a low penetration (e.g.10%), net savings are not obtained. In fact, at such a low penetration level, introducing a DM system costs much more than it saves. However, at 50% penetration considerable savings are obtained up through the first seven or eight years of the program, at which time savings begin to be offset by medical inflation and a constant incidence of injuries. Finally, while savings are possible by targeting all injury groups, selective targeting of high cost injury groups (e.g., lower back injuries) may provide more gain for money spent.

6.5.3. Limitations

The chief limitation to this study is the administrative nature of the database on which inferential analyses were based. As is common with administrative databases, some of the data did not meet expectations. For example, not all fields are populated (e.g., only about 40% of the claimant population had a race reported). For costing information, there are extreme outliers, which while considered and removed, provided cause for concern. The second major limitation of this study was the lack of pre- and post-implementation data. Currently, Texas has not yet implemented a DM model in which to assess pre- and post-intervention outcomes. A third limitation of this study is that the cost estimation models were based on a small number of studies. These studies, while robust, are based in other settings, use a variety of DM interventions, and may or may not be generalizable to the Texas setting. For example, the long-term study used to develop baseline information for each short-term study took place at a major academic medical center (AMC). This AMC, in addition to having a strong medical reputation, has also developed an expertise in treating work-related injuries. Therefore, savings in this study likely represent “a best case scenario.” The final limitation is the lack of detailed cost information on establishing a DM program. Improved costing information would enhance the ability of the model to better estimate long-term costs and savings.

There are also limitations in the ability to provide accurate long-term estimates of cost savings. This is chiefly because the ability to accurately predict future expenditure is related to provider, patient, and economic characteristics that are difficult to predict. For example, changing patient demographics may either over- or under-estimate potential savings. In addition, experience from other settings suggests that providers “adapt” to system changes in ways that continually favor compensation for services rendered. As such, this study concentrated on a five-year forecast.

6.5.4. Future Research

This study has identified several areas where additional research is needed. Some of the analyses yielded interesting results with regard to geography of care. For example, there were variations in WC care by region of service for several independent variables including days off work, cost of care, and utilization of care. Speculation about potential reasons for these differences (e.g., socio-economic status varies across the state) appears in the discussion. Unfortunately, the administrative database used in this study only provides the "numbers" and does not provide an explanation for these numbers. Additional research from a qualitative perspective would be useful to determine why there are differences in cost and outcomes by region. Likewise, an in-depth look at the medical conditions and treatment patterns by region could help determine if these differences are based on medical need or are influenced by resource availability (e.g., more specialized care might be available in the Dallas / Ft. Worth region than in the El Paso / West Texas region).

Future research could also be used to study the implementation of a DM on a pilot basis in Texas. Implementing a methodologically sound pilot DM program and comparing pre-intervention and post-intervention outcomes would provide "real world" data on the potential for DM to improve health outcomes, return injured workers to work, and reduce costs associated with providing WC care. It would provide further support, or lack thereof depending on the findings, for implementing system-wide changes. System-wide changes should not be undertaken until a pilot program has been completed and the results assessed.

Another area of future research is to assess the impact on price and utilization of system changes to the Texas WC system. For example, if networks are developed in Texas, do they exert a strong price effect as reported by Baldwin *et al.* or do they exert a stronger utilization effect? Determining the specific type effect could help identify areas for improvement and aid carriers when making resource allocation decisions.

A final area of future research is to assess economic outcomes by injury group. Disease management research in other areas indicates that economic outcomes may be disorder specific.

6.5.5. Recommendations

6.5.5.1. Pilot Study

Results of this dissertation suggest that there is the potential for improvement in how workers' compensation cases are managed in the State of Texas. Improved management could lead to better health outcomes, a quicker return to work, and reduced expenditure. In order to best determine the impact of changes to the Texas workers' compensation system with regard to disability management, it is recommended that a pilot study be undertaken before any wholesale changes are made. Such a pilot study should be representative of the working population, income characteristics, and geographic regions in Texas. At a minimum it should include a major metropolitan area (e.g., Houston) and a rural area (e.g., West Texas). An example of a pilot program that may be a template for potential action in Texas is the program used by Washington State. However, this model should be appropriately modified to consider unique differences in the Texas system (e.g., data infrastructure to support to the model, the fact that Texas is a voluntary system, etc.).

6.5.5.2. Information Technology Infrastructure Investment

As noted above in section 6.5.3, a chief limitation of this study was the data source. In particular, there were several hypotheses that could not be addressed because of a lack of data or because of the administrative nature of this data. The question then becomes: How can you make sound policy decisions without adequate data? Therefore, it is recommended that TWCC:

(1) Identify key quality metrics that are needed to measure patient health outcomes, disability duration, injury severity, return to work, and economic outcomes;

(2) Identify the types of research that would be useful to TWCC, employers, and carriers, in order to determine the infrastructure and data collection methods needed to develop robust, data-driven research;

(3) Identify methods in which this data could be better collected from carriers (e.g., strengthening reporting requirements from carriers or initiating methods to collect specific data);

(4) Improve the timeliness of information reporting by reducing lag time between medical service occurrence (e.g., a particular billing episode) and reporting to TWCC; and

(5) Invest in appropriate information technology resources needed to collect, measure, and report WC outcomes.

7. Conclusion

Workers' compensation (WC) in Texas, as in other states, has come under renewed attention because of escalating medical and indemnity costs with little, if any, improvement in patient outcomes. Several states and private employers have addressed this problem by implementing a comprehensive approach to providing WC care. This approach is based on the disability management (DM) model. This study reviewed the peer-reviewed literature to date, conducted a series of statistical analyses, and developed a model to estimate costs and savings in Texas from implementing a DM model that included treatment planning.

Based on the analyses conducted in this study, implementing a disease management model that includes treatment planning is estimated to reduce costs associated with workers' compensation care substantially. Specific savings depend on the type of disability management intervention, injury group targeted, and the intensity to which the interventions are integrated into the workers' compensation care process. Policy makers should consider implementing a pilot plan before undertaking any wholesale changes in order to properly evaluate the impact of disability management in Texas. However, if implemented properly, reduced costs and improved health outcomes can be achieved.

Appendix A: Details of Research Studies Reviewed in the Dissertation

Article	Objectives	Study Design	Main Findings	Conclusion
Arnetz *et al*. "Early workplace intervention for employees with musculoskeletal-related absenteeism: a prospective controlled intervention study" *Journal of Occupational and Environmental Medicine* 2003;45(5):499-506. <u>Study intervention:</u> • Injured workers were interviewed to determine personal, social, and occupational characteristics associated with their injury. • One week later the employee, case manager, occupational therapist / ergonomist, and employer met at the workplace. An occupational assessment was conducted. • Ergonomic improvements were made as needed and worker vocational training was conducted as needed. • Employers were encouraged to undertake rehabilitative investigations and make necessary changes in the workplace.	To assess: • The possible beneficial effects from early medical rehabilitation. • Vocational interventions on employee absenteeism and well-being. The hypotheses tested in this study were that employees with musculoskeletal disorders (MSD) who received training in ergonomic improvement and workplace condition adaptation would have less disability days and a faster return-to-work (RTW) than those employees offered standard disease and disability management care. This study took place in Sweden, which operates a national health insurance fund. In case of sickness or disability, employees receive financial assistance. In addition, the Swedish National Insurance Agency (Försäkringskassan, or FK), is responsible for developing a rehabilitation plan with collaboration from the employee, employer, physician, physical therapist, and occupational therapist. The role of the FK is to ensure that an injured employee receives the rehabilitative care deemed necessary.	• Prospective controlled trial. • Setting: Sweden. • Time period: 1 year, but dates not reported. • Study population: ➢ Size: N=137. ➢ 51.1% female. ➢ Mean age: 42.7 and 42.1 years for the intervention andcontrol groups, respectively. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Both genders were included. ➢ Prior history of MSD were allowed so long as the patient had sufficiently recovered in order to RTW. • Data collection: Not reported. • Study notes: ➢ There were no differences in background characteristics between the intervention and control groups. ➢ Data collection occurred at study entry and at 6- and 12-month follow-up. ➢ The cost-benefit analysis used only direct costs. Subjects were systematically allotted to either the intervention or control group. Employees of FK and the data analysis researcher were blinded to the allocation of each patient. Blinding was not possible for the patients, the insurance branch manager, or the ergonomist.	• N=65 for the intervention group (IG) and N=72 for the control group (CG). <u>Results form the National Health Insurance Administration</u> • 84.6% (55/65) of employers in the IG vs. 27.8% (20/72) in the CG submitted rehabilitation investigations to the FK ($p < 0.05$). ➢ IG employers took on average 59.4 days to complete their investigation vs. 126.8 days for the CG ($p < 0.01$). ➢ From the first sick day it took the FK 49.4 and 183.5 days for the IG and the CG, respectively to establish a rehabilitation plan for injured employees. ➢ The time between initial injury and work-related vocational rehabilitation was 88.1 and 190.7 days for the IG and CG groups, respectively ($p < 0.001$). • 41.5% (27/65) vs. 20.1% (15/72) of employees in the IG vs. CG groups had work-oriented vocational rehabilitation deemed inappropriate ($p < 0.05$). Information to explain this difference was not provided, but it could be that IG employees had more intensive planning that was able to identify whether rehabilitation was appropriate. • Externally supplied rehabilitation services were more expensive in the IG vs. CG group at US$6,000 and US$340, respectively ($p < 0.05$). • The likelihood that an IG vs. CG patients would have returned to work at 6 months was 1.9 (95% CI: 1.0 – 3.5; $p = 0.06$) and 2.5 at 12 months (95% CI: 1.2 – 5.1; $p < 0.01$). • There was no difference in the number of reimbursement *days* during months 0-6 and 6-12 for the two groups, however more subjects in the IG (N=23) vs. CG (N=12) received paid rehabilitation during the 12 months ($p < 0.05$). <u>Results from the Questionnaire Data</u> • At baseline there were no significant differences except that IG employees believed they could "influence things" so they could get back to work ($p < 0.001$). • At 6 month follow-up: ➢ 22% of IG vs. 9% of CG employees responded that they had recovered by the time they returned to work ($p < 0.05$). ➢ 88% and 62% of the IG and CG, respectively, reported that the FK was more supportive/important during rehabilitation. ➢ There were no significant differences in health ratings of very good, fairly good, reasonable, rather poor, or poor. <u>Cost</u> • Total patient reimbursement was $9,592 per person in the IG vs. $12,197 per person in the CG ($p < 0.05$; -21.36%) without considering the cost of the intervention. • When the cost of the intervention was included, the cost per patient in the IG increased by $1,410. • Considering the cost of the intervention the IG had a per person cost of $11,002 vs. the CG of $12,197 (no p-value reported).	A 1 year prospective study on the intensive intervention of workplace rehabilitation and adaptations was carried out. Key findings of the intervention vs. control group include: • Case managers at the FK played a more active role in employee rehabilitation. • Days sick from work were shorter. • Likelihood of RTW was 50% higher. • Rehabilitation investigations by employers were completed quicker. • Rehabilitation planning by the FK was completed quicker. • Direct costs were higher for external rehabilitation services. The FK and the ergonomist played a key role in helping employers complete the rehabilitation investigation. In addition, employees had an earlier and more comprehensive rehabilitation and were encouraged to meet with employers, FK officials (e.g., case manager, ergonomist, etc.), and the physician to "decide on necessary steps to enable their return to work." The cost-benefit ratio of the IG vs. CG was 6.8. Despite the high initial cost, it might save money in the long-term. <u>Limitations:</u> Unable to identify which component of the program is most responsible for its success.

Article	Objectives	Study Design	Main Findings	Conclusion
Baker and Krueger "Medical costs in workers' compensation insurance" *Journal of Health Economics* 1995;14(5):531-549.	To determine if: • Patients covered under workers' compensation (WC) insurance are charged more for treatment or receive more services than those covered by traditional insurance. The dependent variable in this study is amount charged for medical care, not the amount actually paid for the service. This was used as the dependent variable because charges: (1) more accurately reflect the behavior of the provider; (2) are comparatively free of factors such as utilization review; and (3) are thought to be of higher quality than the available payment data.	• Retrospective database analysis. • Setting: Minnesota. • Time period: Injuries suffered during the first 6 months of 1987. • Study population: ➢ Size: N=1,976 work related treatment episodes and 5,661 off-work related treatment episodes. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All claims occurring within 15 months of injury. • Study information: Information. • Data collection: ➢ Work injuries and WC data were obtained from Liberty Mutual Insurance company. Liberty Mutual is MN largest underwriter of WC insurance. They provided data on medical claims from all indemnity cases and a random sample of 1,000 medical-only cases. Follow-up of claims for 15 months occurred. ➢ Off work injuries were obtained from Blue Cross / Blue Shield (BC) of Minnesota. They provided a random sample of claims from their fee-for-service (FFS) plan; all claims were for employed workers. 15 months of follow-up data was available & analyzed.	• The average medical charge for work-related injures is $651.22 and $329.89 for off-work related injuries. This calculation did not control for covariate factors. • The unadjusted difference in the mean log total charges for work-related and off-work injuries was 5.260 and 4.703, respectively, a difference of 0.557. • After adjusting for potential covariates, this difference decreased to 0.495 from 0.557. • Charge differences using WC medical only cases (i.e., cases that did not involve eventual indemnity claims) and off-work claims showed a regression-adjusted charge difference for this sample of 0.456, which is close to the difference for the full sample of 0.495. • Charge per service using radiographic procedures and physical examinations were calculated for WC charges and off-work charges. Using regression analysis: ➢ Patients covered by WC are charged more per x-ray and per examination than patients covered by blue cross (note: no attempt was made to distinguish particular type of radiographic procedure; it could be that WC patients had more expensive tests – CT scans – while off-work patients had plain film radiographs). ➢ The regression-adjusted difference for x-rays provided by chiropractors is 0.430 and 0.102 for physicians. ➢ Because quality of service is unlikely to vary in radiographic examination, the price difference is taken to mean that WC patients are charged more than private insurance patients for radiographic examination. • Regression-decomposition charges for hospital charges shows a regression-adjusted difference of 0.226 for outpatient charges and –0.395 for inpatient charges. Thus, BC hospitalized patients are charge more than WC patients, while WC patients are charged more for outpatient care than BC patients. • Regression analysis controlling for injury type, severity, personal characteristics, and geographic distribution showed that *ceteris perabus* WC recipients receive one more examination and slightly fewer x-rays than BC patients.	On average, WC patients are charged more for treatment than their counterparts who receive treatment for similar conditions under private insurance. However, overutilization of services by WC patients "appears to be limited to examinations." One possible explanation is price discrimination. In particular, cost containment of medical only expenses has been until recently uncommon in WC insurance, unlike the private insurance sector. More subtle forms of price discrimination may have occurred in procedural upgrading or unbundling of services to take full advantage of fee schedules. <u>Limitations</u>*:* • Differences in types of and intensities of treatment may not be accounted for. For example, WC patients may receive "expensive special care designed to quickly return them to work." • Unmeasured severity may generate cost-differences (i.e., we may not be controlling for severity the way we think we are).

Article	Objectives	Study Design	Main Findings	Conclusion
Baldwin *et al.* "Effects of provider networks on health care costs for workers with short-term injuries" *Medical Care* 2002;40(8):686-695. In general, networks operate as follows: • Insurers contract with networks to offer health services to injured workers • Networks contract with employers to provide health services at a discount in exchange for preferential patient referrals and a share of the savings • Injured workers see physicians who are part of the network for care related to their occupational injuries. **Note:** This article has an excellent discussion on price discounts and how a network can provide contracting and administrative services and a profit while at the same time receiving lower per unit prices for healthcare.	To examine the effects of preferred provider networks with regard to work-related injuries and: • Health care costs. • Service utilization. Study network details: • The networks in this study are preferred provider organizations (PPO). • These PPOs contract with workers' compensation (WC) insurers to provide health care to employees at a reduced cost. • Each PPO contracts with individual health care providers (e.g., physicians, hospitals, clinics, HMOs, etc.). • Networks agree to provide WC-related care to all employees under contract, but employees are not obligated to choose a network provider. • Networks may not exclude pre-existing conditions. The comparison groups for data analysis were injured workers treated entirely by network providers versus injured workers treated entirely by non-network providers. Case mix and severity were controlled for by matching network with non-network claims.	• Retrospective database analysis with pairwise matching. • Setting: WC claims from California, Connecticut, and Texas. • Time period: Between 1995 and 1997. • Study population: ➢ Size: N=87,000 claims. ➢ Gender not reported. ➢ Mean age: not reported. ➢ Race: not reported. • Eligibility / Inclusion: ➢ The sample was restricted to treatment by either network or non-network provider (i.e., treatments with both providers were not included). ➢ The sample was restricted to medical only claims (i.e., workers who return to work within 2 – 7 days of injury). • Only five common conditions are assessed using ICD-9 codes. ➢ Back pain. ➢ Non-back sprains, strains, and dislocations (SSD). ➢ Inflammations, lacerations, and contusions (ILC). ➢ Fractures. ➢ Cumulative stress injuries. • Matching characteristics: ➢ Gender, injury type, primary ICD-9 code, state, and date of injury. • Data source: WC claims data from California, Connecticut, and Texas.	<u>Overall findings</u> • For all injuries, costs are lower for cases treated in a network vs. those not in a network. • Cost differences, utilization effect, and price effect per case for each of the five categories is as follows: ➢ Back cases: $59 (p = 0.0001); $36; $23. ➢ SSD: $23 (p = 0.0001); -$2; $25. ➢ ILC: $32 (p = 0.0001); -$2; $34. ➢ Fractures: $27 (p = 0.001); $3; $66. ➢ Cumulative injuries: $27 (p = 0.10); $14; $13. • An example explanation is that for back injuries, on average treating a case in network vs. non-network care saves $59. Of this savings, $36 of the savings is due to decreased utilization and $23 is due to decreased costs due to negotiated price discounts. <u>Price effect findings</u> • A positive price effect indicates network providers receive lower prices, per unit of services, than non-network providers. • Price discounts "contribute to the lower costs of network care for all injury groups." ➢ Back cases: 39% of savings due to price effect. ➢ SSD: >100% of savings due to price effect. ➢ ILC: >100% of savings due to price effect. ➢ Fractures: 95.7% of savings due to price effect. ➢ Cumulative injuries: 48.1% of savings due to price effect. <u>Utilization effect findings</u> • A positive utilization effect indicates lower utilization of healthcare services within a network than in non-networks. A negative utilization effect indicates higher utilization of services within a network than in non-networks. • Utilization discounts contribute to lower costs for all but two injury groups. ➢ Back cases: 61% of savings due to utilization effect. ➢ SSD: <0.0% of savings due to utilization effect. ➢ ILC: <0.0% of savings due to utilization effect. ➢ Fractures: 4.3% of savings due to utilization effect. ➢ Cumulative injuries: 51.9% of savings due to utilization effect. <u>Cost savings</u> • Average health costs were $337 for non-network cases and $299 for network cases (difference of $37.19). • Lower utilization accounted for 76.3% ($28.39) while lower prices accounted for 23.7% ($8.80) of this difference. • For claims of less than seven day, overall cost savings were 11.1% in the network group vs. the non-network group.	Networks reduce health care costs by: (1) providing the same services at lower prices; (2) combining price discounts with lower utilization; or (3) combining price discounts with different types of lower cost services. As such, network care within WC can bring occupational injury costs more in line with off the job injuries. The results of this study show the primary driver of lower costs is due to a positive price effect, presumably due to negotiated discounts. Reduced utilization also occurs, but to a less extent. "If networks are appropriating the rents that traditionally have been paid to workers' compensation providers, the networks can achieve substantial cost reductions without compromising the health care provided to injured workers." *<u>Limitations:</u>* • This sample was limited to medical only, short-duration claims. Therefore, the effects of network treatment on long-term claims are unknown. Further studies should be done to determine if these findings hold up over the long-term. • This study was limited to five common conditions and therefore may not be representative of more complex WC conditions. • No measures of patient satisfaction. • No measure of lost workdays after return to work.

Article	Objectives	Study Design	Main Findings	Conclusion
Bernacki and Guidera “The effect of managed care on surgical rates among individuals filing for workers’ compensation” *Journal of Occupational and Environmental Medicine* 1998;40(7):623-631. Specifics of the managed care initiative described include: (1) Employees with a work-related illness must report for evaluation at one of the university occupational health clinics. (2) Specialty care is delivered by in-house occupational health physicians. (3) Medical management guidelines were used to guide treatment decisions to ensure conformity of care across cases. (4) Three separate groups meet to develop a coordinated treatment plan for each worker, to develop RTW strategies for each injured worker, and to plan for worker compensation hearings at the state level if needed.	To determine: • Whether the utilization of managed care techniques (as compared to non-managed care techniques) is related to the rate and type of surgical procedures performed for a defined workers’ compensation population. • Whether the duration of disability associated with surgery differs between the managed and non-managed care group. The Johns’ Hopkins Health System and University (JHHSU) provide medical care to injured workers under an in house network to provide specialty care. Under Maryland law workers are allowed to use any physician, but most injured workers use the JHHSU physicians. “To encourage early diagnosis and the use of non-surgical therapies such as immobilization and ergonomic redesign to possibly avoid the use of surgery to treat these conditions, the procedure for determining causality in cumulative trauma cases was amended.” The amendments included evaluating **all** repetitive trauma complaints; performing a worksite ergonomic survey; review to determine if injury is work-related; determination of compensability; and treatment if necessary.	• Longitudinal cohort. • Setting: Baltimore, MD. • Time period: July 1990 through June 1997. • Study population: ➢ Size: Varied. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All employees who submitted a claim between July 1990 and June 1997 were reviewed to see if they had a surgical procedure. ➢ Files for all claimants who had a surgical procedure were extracted and reviewed. • Study information: Employee figures for each 12 month period were calculated and used to estimate the surgical rates per 1,000 employees. • Data collection: Data extracted from the medical record review of each surgical claim included: ➢ CPT codes. ➢ Date of injury. ➢ Date of surgery. ➢ Treating physician. ➢ Physician’s hospital affiliation. ➢ Return to work (RTW) date. Cohort 1 represents claims occurring prior to introducing managed care (1990-1992) and cohort 2 represents claims occurring during managed care (1993-1997).	• The number of employees insured by the Johns Hopkins self-insured workers compensation system increased from 20,101 in 1990 to 26,621 in 1997. • The number of surgeries prior to managed care (1990-1992) was 163 in 1990, 183 in 1991, and 177 in 1992. • The number of surgeries decreased over time after the introducing managed care (1993-1997) from 152 in 1993 to 101 in 1997. • The overall mean rate of surgery per 1,000 employees before and after managed care includes: ➢ Number of surgeries within 12 months of injury was 1.24 and 0.72, respectively (-42%). ➢ Number of surgeries within 24 months of injury was 1.68 and 1.04, respectively (-38%). ➢ Number of surgeries within 36 months of injury was 1.78 and 1.19, respectively (-33%). ➢ Differences in rates post-managed care when compared to the last year of pre-managed care were statistically significant at the $p \le 0.05$ level in 1995, 1996, and 1997 (except when data is not available due to publication before complete follow-up is available). • At month 36, the frequency of all types of surgical procedures decreased under managed care except for an increase in repetitive trauma or traumatic nerve entrapments. • The most significant decrease in surgical procedure after introduction of managed care was a reduction in spine surgery, from a total of 15 during pre-managed care to 3 during post-managed care. In 1995 there were 0 spine surgeries. • The frequency and percentage of surgery cases completed by Johns Hopkins University (JHU)-affiliated physicians increased after introducing managed care. ➢ Before managed care: 32% (N=35) and 68% (N=74) of surgical cases were performed by JHU physicians and non-JHU physicians, respectively. ➢ After managed care: 9% (N=10; χ^2 $p < 0.001$) and 91% (N=101; χ^2 $p < 0.001$) of surgical cases were performed by non-JHU and JHU physicians, respectively. • The release rate (i.e., RTW within 6 months of surgery) increased for both JHU (85% to 94%; p = NS) and non-JHU affiliated physicians (17% to 60%; p = SS, actual value not reported) after introduction of managed care in the JHU system.	Introduction of a managed care into an academic medical center workers’ compensation system appeared to reduce the level of surgery among claimants. However, other factors which were not controlled for also occurred during this time period and may be partially responsible for the reduction in numbers of surgery. These factors include: • Change in policy with regard to what trauma cases are compensable. • Initiation of an ergonomics program. • Systematic elimination of unsafe work conditions or behaviors. • Imposition of nurse case management and follow-up. • Increased use of academic physicians trained in occupational medicine for diagnosis and treatment. • Development and use of treatment guidelines. In addition, demographic data and other patient characteristics (e.g., comorbidities) were not accounted for. Thus, while this data indicates a significant reduction in surgical cases, further research needs to be done to determine the specific factors responsible for decreases in surgical rates. Limitations: • See uncontrolled factors above.

Article	Objectives	Study Design	Main Findings	Conclusion
Bernacki and Tsai "Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs" *Journal of Occupational and Environmental Medicine* 2003;45(5):508-516.	To describe: • 10 years experience using a system that allows safety professionals, adjusters, and selected medical and nursing providers to collaborate to prevent accidents and to better diagnose, treat, and return individuals to productive work. This program occurred at the Johns Hopkins (JH) Hospital Workers' Compensation program in Baltimore, MD. The purpose of this program was to increase efficiency, outcomes, and return-to-work (RTW) times for injured JH workers. Key measures included patient advocacy, customer service, physician care by a small network of physicians, case management, close follow-up, and dialogue between all parties regarding claim management. Key aspects of the program included early reporting, patient advocacy, care facilitation, and preventative measures to help injured workers return to work. Full details of the program and how it came about are discussed in the article.	• Retrospective cohort. • Setting: Johns Hopkins Health System and University Workers' Compensation Office, Baltimore, MD. • Time period: July 1992 – June 2002. • Study population: ➢ Size: Covered population 1992 N=20,969; 2002 N=39,063. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All employees who sustained an injury between 1992 and 2002 that resulted in a filed workers' compensation claim. All years are in fiscal years that run from July 1 to June 30. For example, fiscal year 1992 runs from July 1, 1991 to Jun 30, 1992.	Note: p-values not reported for all findings. • Absolute number of lost time claims decreased from N=457 in 1992 to N=195 in 2002 while the covered population nearly doubled (from 20,969 in 1992 to 39,063 in 2002). • The number of lost time claims decreased on average 7.3% per year from 21.8 to 6.1 per 1,000 employees in 1992 to 2002, respectively ($p < 0.01$). • Number of medical claims dropped from 155.2 to 61.4 per 100,000 over the study period ($p < 0.01$). • Number of medical hearings dropped from 5.3 per 1,000 in 1992 to 2.5 per 1,000 in FY 2002 ($p < 0.01$). However, in 1994, hearings per 1,000 had increased to 10.0. <u>Aggregate Workers' Compensation expenses</u> • Medical, indemnity, and administration expenses for WC was approximately $5M in both 1992 and 2002. However, as noted above, the covered population nearly doubled during this time. • Total losses per $100 of payroll decreased 54% during the study period from $0.81 in 1992 to $0.37 in 2002. • Absolute medical expenses decreased from $1.7M in 1992 to $1.076M in 1998, but increased to $2.015M in 2002. • Per $100 of payroll, absolute medical expenses decreased from $0.27 to $0.15 in 1992 to 2002. • Temporary total losses fluctuated during the study period from a high of $1.11M in 1992 to a low of $502K in 1997. Increases in 2001 to $1.012M were due to increases in accident severity. • Per $100 of payroll, temporary total losses decreased from $0.18 in 1992 to $0.07 in 2002. • Absolute allocated loss adjustments and other administrative expenses remained stable at about $1.1M during the study period, however, per $100 of payroll decreased from $0.16 in 1992 to $0.09 in 2002. • Without adjusting for inflation, per capita medical, indemnity, and administrative expenses decreased after implementation of the integrated workers compensation program (from 1992 to 2002): ➢ Medical costs from $81 to $52 (↓ 39%). ➢ Temporary/total disability costs from $53 to $23 (↓ 57%). ➢ Permanent/partial costs from $53 to $25 (↓ 58%).	Reductions in lost time and medical only claims is associated with using modified duty, continuous assessment, and improvements of work areas where the injuries occur. <u>Limitations:</u> • Satisfaction with the integrated management program was not formally assessed. However, the Workers' Compensation Commission Hearing rate can be used as a proxy for satisfaction. That is, those who are dissatisfied with how their claim was handled may file a hearing request. This number, while increasing from 5.3 to 10.0 per 100,000 during the first 2 years of the program, eventually decreased to 2.5 per 100,000 after ten years of the program. This suggests that "potential conflicts between supervisors, managers, and claimants decreased because of the methodology used in claims handling." • This study did not evaluate quality of care issues. • This study took place at an academic medical center that had access to specially trained occupational physicians and nurses. Similar levels of specialty care may not be available in the community at large.

Article	Objectives	Study Design	Main Findings	Conclusion
Bernacki and Tsai (2) "Managed care for workers' compensation: three years of experience in an "employee choice" state" *Journal of Occupational and Environmental Medicine* 1996;38(11):1091-1097.	To describe: • 3 years experience in identifying and abating workplace hazards and medically managing cases through an employer preferred provider organization (PPO) established solely for workers' compensation cases. This program occurred at the Johns Hopkins Workers' Compensation Program (JHWCP) in Baltimore, MD. The purpose of this program was to increase efficiency, outcomes, and return-to-work (RTW) times for injured workers. Key measures of the plan included patient advocacy, customer service, physician care by a small network of physicians, case management, close follow-up, and dialogue between all parties regarding claim management. Key aspects of the program included early reporting, patient advocacy, care facilitation, and preventative measures to help injure workers return to work. All findings are discussed in fiscal years that run from July 1 to June 30 each year (e.g., FY 1992 runs from July 1, 1991 to June 30, 1992).	• Retrospective cohort. • Setting: Johns Hopkins University Health System Workers' Compensation PPO. • Time period: 1993 – 1995. • Study population: ➢ Size: Not reported. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All employees who sustained a work-related injury or illness and had a filed workers' compensation (WC) claim were included. • Data collection: Johns Hopkins Self-Insured Workers' Compensation Program. • The baseline year is 1992, the year prior to WC PPO initiation.	• Medical and temporary total disability (TTD) costs decreased steadily from the pre-PPO year of 1993 through 1995, while other costs (e.g., second injury fund, attorney fees, etc.) and administrative costs varied: ➢ Medical costs: \$1.75M (1993), \$1.57M (1994), and \$1.51M (1995). ➢ TTD costs: \$832K (1993), \$702K (1994), and \$670K (1995). ➢ Other costs: \$1.20M (1993), \$1.38M (1994), and \$1.25M (1995). ➢ Administrative costs: \$1.14M (1993), \$1.20M (1994), and \$1.10M (1995). • Overall, total indemnity costs decreased from \$4.92M in 1993 to \$4.52M in 1995. • During the study period, the proportion of medical costs remained steady as a percentage of overall costs (range: 32.3% - 35.6%). The indemnity portion of costs decreased from 46% to 42% and the proportion of administrative costs increased from 20% to 24%. ➢ The decrease in indemnity costs was due to considerably lower costs from TTD payments. • Total per-capita costs decreased from \$241 in 1992 to \$185 in '95 (a decrease of 23%). • Medical costs decreased from \$81 to \$63 per capita from 1992 to 1995, respectively. • TTD costs decreased from \$53 to \$26 per capita from 1992 to 1995, respectively. • Other indemnity losses (e.g., permanent partial, total partial, and permanent total disability) decreased from \$58 to \$51 per capita from 1992 to 1995, respectively. • Administrative costs decreased from \$241 to \$185 per capita from 1992 to 1995, respectively. • The number of TTD days in the JHWCP decreased from 163 days to 70 days per 100 employees from 1992 – 1995. • The number of claims filed with the JHWCP were significantly lower in 1993, 1994, and 1995 as compared to 1992 at 13, 14, 15, and 22 per 1,000 employees, respectively ($p < 0.01$). • Medical only WC claims filed with the JHWCP decreased from 155 in 1992 to 139, 120, and 96 in 1993, 1994, and 1995, respectively (all a $p < 0.01$ when compared with 1992).	As compared to the baseline year of 1992, 3 years of managed care for Johns Hopkins University Workers' Compensation claims reduced the incidence and costs of workers' compensation claims. Most savings were associated with reduced TTD and medical care costs. In addition to the savings, however, the plan incurred some additional expenses, including the addition of a part-time case manager and equipment purchases. <u>Limitations:</u> • Savings associated with this program may not be applicable outside of a health system because of the unique access to highly trained and qualified occupational health staff (e.g., specially trained physicians, nurses, and therapists). • Employee satisfaction was not directly measured, but a survey conducted by a national consulting firm revealed that JHWCP claimants gave the PPO network and clinics a 4.36 mark out of 5. This is considerably higher than the 3.64 mark given by employees treated at Johns Hopkins for non-occupationally related medical problems. • Quality of care issues were not evaluated directly.

Article	Objectives	Study Design	Main Findings	Conclusion
Bernacki *et al*. "A facilitated early return to work program at a large urban medical center" *Journal of Occupational and Environmental Medicine* 2000;42(12):1172-1177. Components of the JHU early return to work (RTW) program include: • A case management coordinator who maintains contact with all interested parties. • An job analysis to identify physical demands of the job. • Development of alternate work assignments that suit the injured worker's restrictions. • Eliminating identified job hazards. • Educating JHU stakeholders (e.g., employees, supervisors) about the RTW process and its benefits.	To present and quantify: • The early return to work process established as part of the Johns' Hopkins University (JHU) workers' compensation integrated care management plan. • The effect of increasing early return to work on the employee, supervisor, and job process when restricted activities are used. The RTW program functions as follows: (1) Injured workers report for evaluation at clinic; (2) Injury is evaluated by occupational health staff; (3) Specialist referral is conducted if necessary; (4) Return to duty form noting restrictions is provided to employee's supervisor. (5) Supervisor indicates whether accommodation can be made. (6) A formal job analysis be requested by the employee or supervisor to determine which tasks can and cannot be done by the employee. (7) If accommodation cannot be reached then the employee receives temporary total disability (TTD) payments. Indemnity payments may also begin. Details of the job analysis procedure are available on page 1174.	• Two longitudinal cohorts. • Setting: An academic medical center in Baltimore, MD. • Time period: Cohort 1 1989-1992; cohort 2 1993-1999. • Study population: ➢ Size: Cohort 1 N = 1,330; cohort 2 N = 1,488 ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ None specified. • Study information: ➢ Cohort 1: This group represents injuries that occurred before implementation of the RTW program. ➢ Cohort 2: This group represents injuries that occurred after implementing the RTW program. • Data collection: ➢ All work-related injuries or illnesses are stored in a computerized database. ➢ Information on non-lost time and lost time cases, time lost from work, and number of restricted workdays came from the Injury Clinic Database. ➢ Number of job analyses performed were obtained from the Health, Safety, and Environmental Department's database.	<u>Cohort 1 – Before implementation of the RTW program</u> • Number of cases with lost workdays per 100 employees ranged from 313 to 352 (mean: 332). • Number of lost workday cases per 1,000 employees ranged from 19 to 21 (mean: 19.8). • The average number of restricted duty cases per 100 employees was 0.63. • Rate of non-lost workday cases was 5.6 per 1,000 employees. <u>Cohort 2 – After implementation of the RTW program</u> • Number of cases with lost workdays per 100 employees ranged from 165 to 248 (mean: 213). • Number of lost workday cases per 1,000 employees ranged from 9 to 11 (mean: 10.0). This is statistically significant from the 1992 lost workday cases rate at $p \leq 0.0036$. Statistical significance was determined using the Bonferroni adjustment or 0.025 / 7 for a two-tailed test. • The average number of restricted duty cases per 100 employees was 13.4. • Rate of non-lost workday cases was 6.0 per 1,000 employees. • Between 1995 and 1999, 168 job analyses were requested by the employee, supervisor, or case manager. Analyses were not conducted prior to 1994 due lack of perceived need. ➢ In one third of cases the industrial hygienist agreed that the injured worker could not meet the restrictions. ➢ In 54% of the time, the employee could be accommodated after suggestions from the hygienist on altering the workplace or changing the job to accommodate the employee. ➢ The number of job analyses requested by employees declined from 15 in 1996 to 1 in 1999, presumably due supervisor's being able to accommodate physician restrictions more appropriately.	The RTW program became an integral part of the JHU initiative to manage its workers' compensation process. However, it is only one part. Therefore, it is difficult to quantify the effect of RTW alone the number and rate or lost workday cases and lost workdays. However, it is possible to quantify the effect on RTW after including an industrial hygienist into the workers' compensation management initiative. Indeed, "when the industrial hygienist became part of the process, the accommodation rate increased by 54%. This suggests that the efficiency of a return to work program can be increased if a third party who is trained in ergonomics and job accommodation is included to assist both the employee and the supervisor in making the appropriate accommodation decision." <u>Limitations</u>*:* • The changes identified in this study took place in an academic medical center. As such, the availability of expert resources is likely greater than found in the general community. Therefore, these results may not easily translate to the community at large.

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Burton and Conti "Disability management: corporate medical department management of employee health and productivity" *Journal of Occupational and Environmental Medicine* 2000;42(10):1006-1012.	To quantify and coordinate: • The extent and duration of short term disability. • Medical services and guidance to managers that would facilitate an early return to work (RTW). Bank One provides benefits to employees as part of the short term disability (STD) program. These benefits include: • Full, half, or no salary depending on length of employment. • Benefits begin after 5 or more consecutive workday absences. • Benefits continue up to 6 months, or 130 workdays. • When applicable, STD benefits are coordinated with WC benefits. • Illness/absences < 7 consecutive workdays are covered under Bank One's sick leave policy. • Illness/absences > 130 workdays are covered under a long-term disability program. • Injured employees who RTW in a part-time capacity (e.g., due to modification) are paid for full-time work as they recover.	• Two longitudinal cohorts. • Setting: United States. • Time period: September 1, 1996 to February 28, 1998. • Study population: ➢ Size: Not reported ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All full-time employees of Bank One who have been employed at least 6 months. • Data collection: In house occupational and nursing database. The STD program is managed by the Bank One corporate medical department. Supervisor's forward information on employees who have been sick ≥ 5 consecutive workdays to the STD program. An information packet containing detailed information about the STD benefits program is sent to the employee's home. The employee is requested to fill out a short form, agree to release of medical records, and submit a form (completed by their physician) noting specific reasons for the disability and anticipated return to work date. Additional copies of the physician form are re-submitted about every 20 days. The corporate medical director may recommend suspending STD benefits for insufficient medical evidence of disability.	Results of this study are compared across two groups for three different periods. Group 1 is the First Chicago office, which during all three time periods, practiced STD management. Group 2 includes the Michigan office which began practicing STD management after the merger. The 3 time periods are: (1) Baseline: 9/1/96 – 2/28/03. (2) Period 1: 3/1/97 – 8/31/97. (3) Period 2: 9/1/97 – 2/28/98. Note: For the Chicago office, the STD program was implemented in the early 1980s, therefore these time periods are primarily applicable to the Michigan office. • STD duration: ➢ For Chicago, STD duration varied only slightly from 9/1/96 to 2/28/03 (range: 22.0 – 23.3). ➢ For the Michigan office, STD duration varied from a high of 29.3 (at baseline) to 23.2 in period 2. By the end of period two the duration of STD in Michigan was the same as that in Chicago (p value not reported). ➢ Similar findings (i.e., a reduction in STD from period 1 to period 2 in Michigan) were seen for STD due to pregnancy and mental health. ➢ In Chicago the average pregnancy-related STD duration ranged from 30.4 – 31.2 over the study period. In Michigan, the baseline STD duration was 34.4, dropping to 28.2 at 18 months after program initiation. ➢ For mental health, the STD ranged from 28.1 to 28.5 in Chicago. In Michigan, STD duration ranged from 42.8 at baseline to 24.9 at 18 months after program initiation. ➢ STD decline of approximately 20% from baseline to 1998 in Michigan represents roughly a $3M savings in STD benefits with only an additional $750K expenditure establish the project. The return on investment is 4:1. • Between 1993 and 1995 STD duration and recidivism rates (defined as an employee away from work for the same primary chronic disease within a 12-month period) were calculated for five disease states: ➢ Diabetes mellitus: 19 mean workdays lost; relapse: 8.3%. ➢ Asthma: 19 mean workdays lost; relapse: 32.7% ➢ Depression: 43 workdays lost; relapse 22%. ➢ Ulcer: 24 workdays lost; relapse 0%. ➢ Hypertension: 25 workdays lost; relapse 8.8%.	This study provides descriptive information regarding the role a corporate benefits department can have on decreasing short-term work disability and improving return to work status to injured workers. <u>Limitations:</u> • Statistical analyses were not performed on the before and after groups, therefore, we are unable to determine if these results are different than would be expected in the population at large.

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Caradoc-Davies and Hawker. "The work rehabilitation impact quotient: a tool to assess the effectiveness of early rehabilitation of injured workers" *Disability and Rehabilitation* 1996;18(12):613-618.	To assess: • The Work Rehabilitation Impact Quotient (WRIQ) as a tool to return injured people to work. The WRIQ compares the percentage of people classified as workers' compensation long term claimants with the percentage of all long term claimants. A WRIQ > 1.0 indicates that more people than expected remain on compensation. The WRIQ is calculated as follows: WRIQ = (D/C) / (B/A) where D = the number of long term claims in the group under study; C = number of claims in the group under study; B = number of long term claims; and A = total claims for the specified year. Details of the WRIQ are available on page 614.	• Retrospective database analysis. • Setting: New Zealand. • Time period: April 1, 1988 through June 30, 1994. • Study population: ➢ Size: Not reported. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Only workers injured at work were included. ➢ Subgroups with cells less than 50 cases were excluded because of considerable variance being produced by small changes in numbers. • Data collection and statistical analyses: ➢ The New Zealand Accident Rehabilitation and Compensation (ACC) Insurance Corporation database of injured workers. ➢ Statistical analysis was conducted on three groups divided into high (WRIQ > 1.14), medium (WRIQ 1.05 to 1.14), and low (WRIQ < 1.05). ➢ Independent variables: % change in workforce from 1986-1991 (to indicate job availability), injury rate per 1,000 workers (comparing ACC and census figures for 1991), mean claim costs during financial year of registration, and mean claim cost by group during 1994 (to reflect present day costs).	• Analysis by age group showed that claimants > 50 had a high WRIQ. • Between 1988 and 1992, workers < 15 had a high WRIQ. • There were no significant differences in WRIQ between males and females. • The WRIQ of claimants paid by the motor vehicle account was consistently higher than other accounts (mean: 1.17 vs. 0.97). <u>WRIQ by body part and diagnosis</u> • Those with injuries to the head, elbow, knee, and multiple locations had a WRIQ > 1.05. • Those with amputations, dislocations, fracture, injuries to internal organs, and occupational overuse syndrome (OOS) had high WRIQs. • Those with dermatitis, inhalation disease, and "other occupational injuries" had high WRIQs. <u>WRIQ by industrial group</u> • Logistic regression showed thata higher WRIQ was associated with higher costs ($p < 0.05$). • Analysis by New Zealand Standard Industrial Classification Codes revealed: ➢ Construction and finance had a very high WRIQ. ➢ Agriculture, mining, transport, and community and personal services having a high WRIQ. ➢ Manufacturing, electricity generation, and trade had a low WRIQ. <u>WRIQ by occupational group</u> • Logistic regression showed a higher WRIQ was associated with higher costs ($p < 0.05$). • Analysis by new Zealand Standard Classification of Occupations Codes revealed the following WRIQs: ➢ Very high among the armed forces and legislators. ➢ High among clerks, technicians, trades people, and agricultural workers. ➢ Low among professionals, services, plant operators, and elementary occupations (e.g., building caretakers and cleaners, messengers and doorkeepers, refuse collectors, and freight handlers). ➢ Nurses and midwifes had surprisingly low WRIQs considering the rate of back injuries in these groups.	Workers aged less than 15 and greater than 50 had high WRIQs. Yet, there was no gender difference in WRIQ, indicating that even though the male claim rate was twice that of the female claim rate, claim closures were similar. Detection of high WRIQs associated with specific body parts (e.g., the elbow and knee) indicated that workers with these injuries should be targeted for intensive rehabilitation. Analysis by industry revealed "no statistical relationship between the WRIQ and changes in the structure of the work force, the injury rate, or the level of compensation paid during the 1994 financial year." Costs paid during the 1994 financial year give an impact of the amount of money that could be saved if injured workers could be moved from the very high to high or to low groups. However, the additional expense of rehabilitation and medical care to achieve a lower WRIQ group may negate some of the savings. <u>Limitations</u>*:* • There were several problems with the database (e.g., claims closed with no indication of reason). • Results may not be generalizable beyond the New Zealand work force.

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Cheadle *et al*. "Factors influencing the duration of work-related disability: a population-based study of Washington State Workers' Compensation" *American Journal of Public Health* 1994;84(2):190-196.	To examine: • Factors predictive of duration of work-related disability. Disability is defined in this article as losing the "capacity to meet occupational demands as opposed to [losing] personal or social functioning."	• Population-based, retrospective cohort design. • Setting: Washington State. • Time period: 1987 - 1989. • Study population: ➢ Size: N=28,473 ➢ 26% female. ➢ Mean age: Not reported. ➢ Race: Not reported. ➢ Mean duration of follow-up: 35.4 months. • Eligibility / Inclusion: ➢ Claims involving 3 or fewer days were excluded. ➢ Claims from self-insured employers whose reporting criteria are inadequate for research purposes were not included. ➢ Claims with one or missing independent variables were deleted from the analyses. • Study information: Duration of disability was the principal outcome measure. • Data Source: Claims and medical bill databases from the Washington Department of Labor and Industries. • Data collection: Because of the large number of claims the authors imposed the additional criterion of "stability" to determine which results to emphasize (p. 192).	• The largest single injury reported (in quantity) was back sprain (34%) followed by other sprains and strains (20%). • Mean duration of disability was: ➢ Carpal tunnel: 159.9 days. ➢ Back/neck sprain: 145.6 days. ➢ Fracture: 126 days. ➢ Other sprain: 110.4 days. • Survival analyses indicated that most disability is short-term: ➢ Over half return-to-work (RTW) by 1 month. ➢ Less than 20% remain disabled at 6 months. ➢ 17.5% of all claims involved at least 6 months of lost time, 12% involved 1 year of lost time, and 7.4% involved at least 2 years of lost time. • Selected relative hazards (i.e., longer duration of disability):* ➢ Males 1.0, females 0.85. ➢ Age ≤ 30 1.0, age 45+ 0.67. ➢ No dependents 1.0, dependents 0.88. ➢ Fracture 0.88, other sprain 0.87, back/neck sprain 0.79, and carpal tunnel 0.55. ➢ No hospitalization 1.0, hospitalization 0.48. • Workers in counties with high unemployment rates and those in general construction were more likely to have claims of longer duration. * To interpret the relative hazard, comparisons are made between the baseline variable (at 1.0) and other variables. For example, as compared to male workers, female workers have a 15% longer duration of disability due to any injury (relative hazard of 0.85).	After adjusting for initial hospitalization, factors that predicted longer duration of disability included: • Older age. • Female gender. • Diagnosis of carpal tunnel .syndrome or back/neck sprain An interesting finding is that larger firms have shorter disability durations. This may be because large firms are able to employ disability management specialists; small firms may have disability benefit exemptions; and smaller firms may have higher turnover and less access to disability prevention information. Strengths of the study were that it was population based, had a mean follow-up of nearly 3 years, and adjusted for hospitalization with 28 days of injury. <u>Limitations:</u> • Data were from an administrative database and subject to errors. • The results are specific to Washington State. • Worker, firm, and industry characteristics were measured only at the time of injury.

Article	Objectives	Study Design	Main Findings	Conclusion
Cheadle *et al*. "Evaluation of the Washington State Workers' Compensation managed care pilot project II" *Managed Care* 1999;37(10):982-993. Note: The results in this study may use one of two approaches: (1) more conservative; and (2) less conservative. The difference between the two approaches is because "a substantial minority (38%) of medical care in the managed care group was provided by non-network providers." Because of this a majority of non-network bills were denied and no payment was made. The more conservative approach included <u>all</u> non-network costs in the analyses. The less conservative approach assumed the first non-network visit was appropriate and subsequent visits were not. Most results are reported using the less conservative approach.	To examine: • The effect of managed care on medical and disability costs as part of an evaluation of the Washington State Workers' Compensation managed care pilot. This study summarizes the medical and disability cost from a managed care workers' compensation (WC) program compared to the traditional fee-for-service (FFS) program. The intervention in this study involved changing: • The method of payment at the plan level from a Department of Labor and Industry FFS schedule to experience-rated capitation. • The delivery of care at the clinical level from seeing "any doctor" to seeing a physician trained in the occupational-medicine model. This model "emphasizes care coordination and ongoing follow-up aimed at getting the injured worker back to work in a timely manner." No specific hypotheses regarding the effect of managed care on disability costs were identified because no published studies had previously addressed this issue.	• Retrospective cohort. • Setting: Eight county area in Washington State. • Time period: April 1995 to March 1996. • Study population: ➢ Size: N=1,058 for MC and 1,159 for FFS. ➢ 18.7% female for MC and 17.8% for FFS. ➢ Mean age: 33.4 years for MC and 33.5 years for FFS. ➢ Race: Not reported. • Data sources: ➢ Washington State Department of Labor and Industry (DLI) Medical Information Payment System (MIPS). Costs were measured based on charges submitted from FFS providers. MC providers submitted "shadow bills" so cost and resource utilization could be determined. That is, even though MC physicians were paid via capitation they were asked to submit charges for each service rendered so a proper comparison with FFS could be carried out. Specific assignable cost categories included: inpatient utilization, outpatient surgeries, outpatient visits, laboratory and x-ray, physical therapy, pharmaceuticals, and all other costs.	<u>General characteristics</u> • Worker and injury characteristics of the MC and FFS groups were very similar, with none exhibiting statistically significant differences. • Most importantly the injury mix was similar between the 2 groups. • Overall costs were 32.3% lower in the MC vs. FFS group. <u>Utilization of medical services</u> • There was very little difference in inpatient utilization between groups. ➢ Hospitalizations per 1,000 injuries was 8.5 and 4.3 in MC and FFS, respectively ($p = 0.21$). ➢ Mean number of days hospitalized per 1,000 injuries was 55.8 and 24.2 for MC and FFS, respectively ($p = 0.39$). • For outpatient services, visits per injury were 22.9% higher for FFS than MC (3.5 vs. 2.7; $p < 0.01$). • The number of outpatient visits per provider type varied between groups (MC vs. FFS): ➢ General practitioner: 1.9 vs. 0.9 ($p < 0.01$). ➢ Chiropractor: 0.3 vs. 1.8 ($p < 0.01$). ➢ Other providers: 0.6 vs. 0.8 ($p < 0.01$). • Using the more conservative approach, the total number of outpatient visits increases from 2.7 to 3.1, thus eliminating the statistical difference between MC and FFS. <u>Medical costs</u> • Overall medical costs were lower under MC than FFS. ➢ Mean medical cost per injury was \$587 in MC and \$748 in FFS ($p = 0.06$). ➢ Using the more conservative approach, MC costs ↑ to \$619, ↓ the difference to 17% from 22% ($p = 0.15$). ➢ The only statistically significant cost differences were for GP, chiropractor, pharmacy, and all other services (all $p < 0.01$). • Multivariate regression was performed to see if differences in costs were related to differences in injuries. Patient, injury, and firm factors had little meaningful effect on results. • Outliers, however, influenced total costs. Specifically, one MC outlier (\$57.7K), when excluded under the more conservative assumption, increased total cost differences from 17% to 24% ($p < 0.01$). • Both the percent of injured workers on time loss (14.7% vs. 19.2%) and time-loss payment amount (\$342 vs. \$625) were lower in the MC group vs. FFS (both $p < 0.01$). • # days on time loss was lower for MC vs. FFS (9.8 vs. 14.3 days; $p = 0.13$). • Overall, medical costs decreased by 28.4% in the MC group vs. the FFS group. <u>Indemnity costs</u> • Indemnity costs were significantly lower in the MC group vs. FFS group (\$342 vs. \$625; $p = 0.01$). • Indemnity costs were 50% less in the MC than FFS groups.	Generally, costs were lower for the MC than FFS groups in this study. However, these differences, on the whole were not statistically significant for unadjusted values. However, considering the effect of outliers in the managed care group and removing an one outlier, MC costs were 24% less than FFS costs ($p<0.01$) using the more conservative cost assumptions. Hospitalization rates and costs were higher in MC, but the MC group had lower rates of both outpatient visits and outpatient surgeries. <u>Limitations:</u> • Inability to randomize firms to the MC or FFS group. • Self selection of firms and the incentive of a 5% premium discount on workers' compensation premiums associated with self selection, could have biased participants in the MC arm of the trial.

Article	Objectives	Study Design	Main Findings	Conclusion
Christian "Return to work outcomes following Accident Compensation Corporation work capacity assessment" *New Zealand Medical Journal* 2002;115(1153):209-211.	To determine and assess: • The proportion of Accident Compensation Corporation of New Zealand (ACC) claimants who had a work capacity assessment (WCAP) by a medical assessor that indicated a capacity to return to work (RTW), but who did not RTW. • What factors impacted on the injured workers RTW. • Whether the ACC's method and findings regarding RTW numbers for injured workers are valid and reasonable. The WCAP is an assessment test used by the ACC to determine if a claimant is ready to: (1) return to work after rehabilitation; (2) resume a 30-35 hour work schedule; and (3) cease receiving ACC compensation. The WCAP includes assessment by an occupational assessor to determine the type of job and job functions suitable for that worker based on their injury and treatment. Claimants are then referred to a medical assessor to determine if the claimant has the capacity to work the minimum hours in each job option identified by the assessor. If assessed as being able to work in one of the job options, claim payments cease after 3 additioanl months.	• Retrospective, telephone survey. • Setting: Wellington, New Zealand. • Time period: WCAP assessment between July 1, 1998 and June 30, 1999. Telephone survey conducted in November, 2000. • Study population: ➢ Size: N=141. ➢ Response rate: 76%. ➢ 46% female. ➢ Mean age: Not reported. ➢ Race: 9% Maori. • Eligibility / Inclusion: ➢ Injured workers who were assessed during the time period above were eligible to be included in this study, pending consent. • Data collection: Telephone survey by a private physician. Questions included: ➢ Was the WCAP process fair? Do you still receive ACC compensation? Are you currently working 30 hours a week or more? Gender? Ethnic group, race, or culture? Over 40? Where on your body was your injury? Was your work at the time of injury heavy or light? Did the ACC provide retraining?	• 80% felt the WCAP process was unfair. • 67% worked in heavy manual work at time of injury. • 82% reported no retraining from ACC after injury. • 15% (N=21) claimants still received ACC weekly compensation. <u>Data based on injury site:</u> • 56% (N=79) had back injuries: ➢ 62% were men. ➢ 77% occurred during heavy physical labor. ➢ 52% were working ≥ 30 hours per week. • 39% (N=55) had arm injuries: ➢ 58% were women. ➢ 38% were working ≥ 30 hours per week. • 25.5% (N=36) had neck injuries: ➢ 58% were women. ➢ 52% were working ≥ 30 hours per week. <u>Statistically significant findings</u> • Those not on ACC compensation were more likely to be working than those still on ACC compensation (52/120 vs. 1/21; χ^2 $p = 0.0008$). • Claimants who had retraining were more likely to still receive ACC compensation than those without retraining (8/26 vs. 13/115; χ^2 $p = 0.01$). • Significant findings using logistic regression include ($p < 0.05$): ➢ Claimants seen earlier in the sample period were more likely to be working than those seen late in the sample period. ➢ Claimants seen later in the sample period were more likely to be on ACC status. ➢ Claimants over > 40 years were less likely to be working than claimants < 40 years old. • In this study 45.6% (N=52) of claimants work 30 hours or more, while the ACC estimates that 79% of workers work 30 hours or more (after having stopped receiving ACC compensation). The difference is statistically significant (χ^2 $p < 0.001$).	This report provides first hand data regarding RTW and disability payment status for a single office sample of injured workers patients in New Zealand. Data from this study show that fewer workers have returned to work than reported by the ACC. It is likely, however, that the ACC data is inaccurate. This is because the ACC uses cessation of benefits as a proxy for returning to work. Yet, benefit cessation does not necessarily mean the person has gained employment. \Rather, it means they are just no longer receiving ACC benefits. One unexpected finding in this study is that patients with rehabilitation training were more likely to be receiving ACC benefits then those who did not receive retraining. It could be that those who need retraining have more severe injuries and thus take longer to reach the RTW state. <u>Limitations:</u> • This study is based on a single practice. Therefore the claimants may not represent a heterogeneous population. • This study depended totally on claimant recall.

Article	Objectives	Study Design	Main Findings	Conclusion
Dasinger *et al*. "Doctor proactive communication, return-to-work recommendation, and duration of disability after a workers' compensation low back injury" *Journal of Occupational and Environmental Medicine* 2001;43(6):515-525.	To investigate the impact of the following two factors on disability duration as perceived by the patient/injured worker: • Doctor-initiated communication about the worker's job, how to help the injury heal, how to avoid re-injury, and specific work restrictions. • Doctor communication to the worker about return to work (RTW) status. Data were obtained from a telephone survey of 850 claims with a 60% (N=433) response rate. For each claim an acute care physician and a chronic care physician were identified. The former was designated as PTP-1 and was responsible for treatment during the first 30 days, the latter was designated PTP-2 and responsible for treatment from day 31 – 90. Interview questions reflected two main categories: (1) doctor pro-activity; and (2) RTW recommendation. Both variables were studied separately using COX regression analysis with worker cessation of receiving WC benefits as the outcome of interest. Additional controlling factors were studied in up to four models.	• Retrospective survey. • Setting: Northern California. • Time period: Interviews between July and December 1997. • Study population: ➢ Size: N=433 successfully interviewed. Analysis limited to 325 who had all covariates. ➢ 30% female. ➢ Mean age: 70 years. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Diagnosis of low back pain (LBP) on any MD bill within 14 days of injury or definite LBP diagnosis within 90 days. ➢ Injury date between 1994 and 1996. ➢ At least 1 day of temporary disability within 14 days of date of injury. ➢ LBP could not be due to fracture, neoplasm, infection, or inflammatory disease during life of claim. ➢ The injury could not have a burn, open wound, or inflammatory disease during claim. • Data collection: ➢ Data was collected by a telephone survey. Four models, in addition to the PTP bivariate model were used in the Cox regression: (1) Adjusted for age and sex; (2) model 1 + injury factors; (3) model 2 + physical and psychological factors; and (4) model 3 + employment factors.	<u>Workers' perceptions of their doctors care by PTP</u> • Overall both PTP-1 and 2 received a high marking on the doctor pro-activity scale (58.2% and 57.3%, respectively): ➢ Respondents noted that 58.9% of PTP-1 and 63.3% of PTP-2 physicians talked with them some or a lot about their job activities. ➢ Respondents noted that 68.8% of PTP-1 and 69.6% of PTP-2 physicians seemed to understand fairly or very well the things the worker did at work. ➢ 64.9% of PTP-1 and 2 physicians told workers how to avoid work injuries while 60.5% of PTP-1 and 59.3% of PTP-2 physicians suggested changes in how workers did their job to prevent re-injury. ➢ 64.4% and 64.6% of PTP-1 and PTP-2 physicians, respectively ever told the worker they were ready to go back to work. <u>Results of Cox regression analyses</u> • Across all acute phase models, workers who received care from a doctor perceived to be proactive or who said they were ready to RTW were 20 – 39% more likely to RTW at any time than workers treated by non-proactive doctors or doctors who did not tell them they were ready to RTW. Not all values were statistically significant. ➢ Bivariate PTP-1: RTW rate = 1.39; p = 0.05. ➢ For all other models and the bivariate PTP-2, the RTW rate was not statistically significant at $P \leq 0.05$). • In the sub-acute to chronic phase, pro-activity by PTP-2 was not significantly related to RTW rate ($p \geq 0.43$). • However, for PTP-2 physicians, saying the worker was ready to return to work in the sub-acute to chronic phase patients returned to work quicker in all but model 4. ➢ Bivariate PTP-2: RTW rate = 1.67; p = 0.01. ➢ Model 1 PTP-2: RTW rate = 1.68; p = 0.01. ➢ Model 2 PTP-2: RTW rate = 1.63; p = 0.01. ➢ Model 3 PTP-3: RTW rate = 1.61; p = 0.02. ➢ Model 4 for PTP-2 was not statistically significant.	This study shows that physician pro-activity may influence duration of RTW status in the acute phase, but not in the sub-acute / chronic phase (once factors are controlled for). In addition, the effect of PTP-1 pro-activity disappeared when covariates were added to the model, indicating that these factors (e.g., work and employment factors) are independent predictors of RTW. Accordingly "once physical and psychosocial workload are considered … workplace factors may overwhelm any positive influence that physician pro-activity may have on the RTW process." In the sub-acute / chronic phase, physicians informing the patient that they are ready to return to work had a significant effect on all models, except when employment factors (e.g., union membership, pre-injury employment, and total employer payroll) were considered. <u>Limitations:</u> • This study is based on retrospective reporting lasting up to 3 years, depending on the date of injury, and therefore may be subject to recall bias. • A patient's outcome may have influenced how they recall their treatment (e.g., a good outcome may have led them to recall good physician pro-activity, etc.).

Article	Objectives	Study Design	Main Findings	Conclusion
Dembe *et al*. "Inpatient hospital care for work-related injuries and illnesses" *American Journal of Industrial Medicine* 2003;44(4):331-342.	To compile: • Descriptive information about the characteristics of inpatient hospital care provided for work-related injuries and illnesses covered under workers' compensation insurance in the United States.	• Retrospective database analysis. • Setting: Data from approximately 24 participating states. • Time period: 1997-1999. • Study population: ➢ Size: N=126,989. ➢ 25.2% female. ➢ Mean age: 43.3 ± 13.3 years. ➢ Race: 77.6% white. • Information. • Data collection: ➢ Nationwide Inpatient Sample (NIS) from the US Agency for Healthcare Research and Quality. ➢ This study focused on hospital stays involving work-related injuries covered by WC insurance. • Statistical analyses: ➢ Univariate summary statistics. ➢ Three year trend values. ➢ Multivariate linear regression to evaluate the effect of WC payment on various characteristics of care. Two regression models were used: (1) age, gender, and region of state as covariates; and (2) age, gender, and state as covariates.	<u>Descriptive characteristics for WC inpatient hospital care</u> • Total charges per stay: $14,996 (mean); $9,109 (median); $54,049 (SD). • Length of stay (LOS) in days: 4.01 (mean); 2.0 (median); 13.63 (SD). • Days from admission to first principal procedure: 0.58 (mean); 0.0 (median); 5.44 (SD). • Number of procedures per hospitalization: 1.94 (mean); 1.0 (median); 4.07 (SD). • Note that "the distribution of these variables is highly skewed, with a small proportion of severe cases substantially affecting the observed results." • Disc and spinal disorders, fracture of lower limb, and complications (device, implant) represent the three most common causes of WC hospitalization at 27.9%, 6.4%, and 4.0%, respectively. 2 of the 10 most common causes of WC hospitalization involve medical and surgical complications. <u>Three year trend data (1997 – 1999)</u> • The absolute number of WC hospitalizations and proportion of WC cases as a % of all hospitalizations declined sharply during the study period by 7% and 14%, respectively. • Average WC hospital charges increased by 16% as compared to 9% for non-WC hospital charges (p value not reported). • 16% ↓ in hospitalizations for work-related disc and spinal disorders, accompanied by a 30% ↓ in inpatient laminectomies paid by WC. • Hospitalizations for sprains/strains fell by 25%, there were 16% fewer knee arthroscopies, and similar decreases in inpatient stays for lower and upper limb fractures for WC patients. <u>Regression analyses</u> • Disk and spinal disorders: WC paid more than other payers, and had more procedures after controlling for age, gender, and geographic region of state. After controlling for age and other covariates WC patients had a longer LOS (0.12 – 0.15 days) than other payers. For both models time to 1st procedure was 25% shorter for WC patients. • Upper or lower limb fractures: For both models WC care had shorter duration to first procedure (by 11%), involved more procedures (by 19%), and had shorter LOS (by 26%) than other payment sources. • Overall WC care has more procedures and shorter length of time to first procedure than do other payers.	WC inpatient hospital care represents 18.8% of total WC medical care expenditures. However, actual payment may be substantially reduced once discounts to usual and customary charges are considered. In addition, three year trend data shows an increase of hospital charges for WC care as compared to non-WC care. A possible explanation is that much of WC hospital care has shifted to the outpatient setting. Therefore, remaining hospitalized cases may be more severe. The increase could also be due to "WC hospital charges [that] exceed the actual increases in costs or payments, and may partially reflect the widespread use of WC state hospital payment regulations, which typically authorize payments to be based on "cost-to-charge" conversion factors." <u>Limitations</u>*:* • Information on nature, cause, or severity of patient condition is unavailable. • NIS does not contain information on occupation, industry, co-morbidities. • This study relied on proper coding of job-related injuries, but not all legitimate job injuries are reported to WC. • Hospital charges, not payment information are reported. • Trends represent 3 year data and may not accurately represent long-term trends.

Article	Objectives	Study Design	Main Findings	Conclusion
Feldstein *et al*. "Prevention of work-related disability" *American Journal of Preventive Medicine* 1994;14(3S):33-39. An effective approach to preventing workplace injuries is to help employers determine the need for and implementation strategies to encourage protective equipment programs, hazard information, communication training, industrial hygiene training, hazard and safety consultation, ergonomic consultation, stress management, and employee assistance. The case management approach is one way to achieve these goals. In this study, the managed care organization (MCO) assigned a nurse/physician case management team to each contracted employer. Details of this employer/case management relationship are on page 34. **Note:** This article provides extensive and interesting details of case management with an MCO.	To describe the role of managed care in preventing work-related disability through: • Consultation. • Training. • Immunization programs. • Targeted screening. • Case management activities. This article is more descriptive than inferential, but it provides useful information on an MCO case management program.	• Study design: Not reported. • Setting: Oregon. • Time period: Varies. • Study population: ➢ Size: Not reported ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: Not reported. • Study information: The intervention group was the Kaiser Permanente Northwest "on-the-job" program. Control group information was not reported. • Data collection: Kaiser data was collected in a clinical encounter database. Inferential analyses were conducted on the average time loss per time loss claim for back claims and for the average total claims cost paid per time loss. However, the comparison dates for analysis 1 and there is no justification for the start and stop dates used. For the comparison involving two MCOs vs. the Kaiser case management approach, no details of the MCO selection were provided.	• Physician authorized average time loss per time loss claim for back claims decreased from 1991 to 1995 for the Kaiser program (p =0.0098): ➢ 1991: 808 claims with average disability of 17.8 days per case. ➢ 1995: 691 claims with average disability of 15.0 days per case. • The average number of total claims cost paid per time loss was lower in the Kaiser program vs. two other MCOs between July 1994 and June 1995: ➢ MCO 00: Average claim cost of $4,683.93 vs. Kaiser average claim cost of $3,013.05 (p = 0.0002). ➢ MCO 01: Average claim cost of $4,379.33 vs. Kaiser average claim cost of $3,013.05 (p = 0.002).	MCO that use a case management model may be able to achieve savings. However, the results from this study should be viewed with caution since important information to assess the appropriateness and robustness of the study design and methodology are unknown. At best, this study represents an first piece of evidence on potential cost savings, but other analyses must be conducted using <u>*robust methodological research designs*</u>. <u>*Limitations:*</u> • Lack of information on study design and methodology. • Results should be interpreted with caution and should not be used to justify reform efforts in WC to a managed care approach.

Article	Objectives	Study Design	Main Findings	Conclusion
Feuerstein *et al*. "Integrated case management for work-related upper-extremity disorders: impact of patient satisfaction on health and work status" *Journal of Occupational and Environmental Medicine* 2003;45(8):803-812.	To assess: • The satisfaction among patients receiving integrated case management (ICM) vs. regular case management. • Whether patient satisfaction with ICM would be able to predict level of upper extremity symptoms, functional limitations, and a shorter return to work. The purpose of this article was to assess patient satisfaction with the ICM model. Compared to the typical case management model, which concentrates primarily on medical management, the ICM model concentrates on medical management, the work environment, and the claims process. In particular, patients receiving ICM have an initial standardized interview, training in proper ergonomics, and have a case plan designed to help them return to work sooner.	• Prospective, randomized intervention trial. • Setting: US federal civilian workers. • Time period: Claims from March 1999 to December 2000. • Study population: ➢ Size: N=131 ➢ 77.9% female. ➢ Mean age: 46.0 years. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Work-related upper extremity (WRUE) disorder. ➢ Between ages 18 and 65. ➢ No claims in the previous two years. ➢ Have one of the following WRUE ICD-9 diagnosis claim numbers: 353, 354, 715, 723, 726 - 729. ➢ Acceptance / adjudication of claim within 90 days. • Data collection: Pre- and post intervention surveys (6 and 12 months). The following questionnaires (N = number of items if noted in the article) were used to assess patients. • Baseline information. • Patient satisfaction (N=13). • Upper-extremity pain and symptoms (N=11). • Upper-extremity functional limitations (N=12). • General health status/SF-12. • Ergonomic factors (N=38). • Problem solving (N=7).	This study randomized patients into two treatment groups: (1) usual care (UC); and (2) ICM care. (For more details see page 804). <u>Patient satisfaction</u> • All items on the patient satisfaction survey were summed to form a single score (range: 13-65) based on factor analysis. • ICM patients had a higher total patient satisfaction than the UC patients (55.9 vs. 41.3; $p < 0.01$). • At 1 month post-intervention, ICM group assignment was a predictor of patient satisfaction using linear regression (95% CI: 9.57-18.49; R^2: 0.30; $p < 0.01$). No other variables (e.g., age, gender, severity, etc.) were predictors of satisfaction. • Predictors of upper-extremity symptom severity included: ➢ Patient satisfaction at 6 months post-intervention, accounting for 4% in the variance increase ($p < 0.05$). ➢ Ergonomic exposure 12 months post-intervention, accounting for 4% in the variance increase ($p < 0.05$). ➢ General distress at both 6 and 12 months post-intervention, accounting for 7% and 10% in the variance increase at 6 and 12 months, respectively ($p < 0.01$ for both time points). • Predictors of greater upper-extremity functional limitations at: ➢ 6 months: female gender ($p < 0.01$; delta R^2: 0.10), general distress ($p <$ 0.0.5; delta R^2: 0.05), and patient satisfaction ($p < 0.05$; delta R^2: 0.05). ➢ 12 months: female gender ($p < 0.01$; delta R^2: 0.11), general distress ($p < 0.01$; delta R^2: 0.09), usual care treatment group ($p < 0.05$; delta R^2: 0.04). <u>Return to work</u> • 59 of 131 (45.0%) of respondents had return to work (RTW) data. • There were significant differences ($p < 0.05$) in the distribution of gender for those retained for RTW analyses vs. those not retained. A greater portion of women were excluded. • Regression analyses indicate that older age, upper-extremity functional limitations, and lower levels of patient satisfaction at post-intervention assessment "significantly predicted longer duration to RTW, accounting for 28% of the variance" (all $p < 0.05$).	This study highlights the benefits of ICM vs. UC on patient satisfaction and the impact of patient satisfaction as a predictor of upper-extremity symptoms and functional limitations at 6 and 12 month post intervention assessments. Some interesting results of this study include: • ICM services were associated with higher levels of patient satisfaction. • Higher levels of satisfaction predicted lower levels of upper-extremity limitations at 6 months post-intervention and a more rapid RTW at 12 months post-intervention. These results suggest that ICM, and its tailored patient approach, contributes to the recovery process. In addition, ICM case managers spent more time with patients (approximately 3 – 4 hours). However, spending more time with patients may have influenced patient outcomes. <u>Limitations:</u> • The number of statistical comparisons with a sample size this small could inflate type I error (i.e., leading us to believe that there are differences when there are none).

Article	Objectives	Study Design	Main Findings	Conclusion
Green-McKenzie *et al.* "Comparison of workers' compensation costs for two cohorts of injured workers before and after the introduction of managed care" *Journal of Occupational and Environmental Medicine* 1998;40(6):568-572.	To describe and determine: • The effects of a managed care intervention program. • The costs savings attributable to the introduction of the manage care program among injured workers receiving workers' compensation (WC) employed at an academic medical center. This program occurred at the Johns Hopkins Workers' Compensation Program (JHWCP) in Baltimore, MD. The purpose was to increase efficiency, outcomes, and return-to-work (RTW) times for injured workers. Key measures included patient advocacy, customer service, physician care by a small network of physicians, case management, close follow-up, and dialogue between all parties regarding claim management. Key aspects of the program included early reporting, patient advocacy, care facilitation, and preventative measures to help injury workers return to work. Prior to managed care, injured workers reported to the WC clinic for evaluation and were evaluated by a part-time occupational medicine physician and full-time occupational health nurse. Care was managed by a provider of the patient's choice.	• Two longitudinal cohorts. • Setting: Johns Hopkins Medical Institutions (including the hospital and university). • Time period: Cohort 1: July 1, 1989 to June 30, 1992; Cohort 2: July 1, 1992 to June 30, 1995. • Study population: ➢ Size: Total N=20,969. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All employees who sustained a work-related injury or illness in fiscal year 1990 or 1993 that resulted in a claim. • Data collection: ➢ Claims data came from the JHWCP. ➢ Annual compensation data came from the JHWCP. ➢ Loss data was based on actual expenses paid. <u>Cohort 1:</u> Entry into study from July 1, 1989 to June 30, 1990 with follow-up to June 30, 1992 comprises the pre-managed care population. <u>Cohort 2:</u> Entry into study from July 1, 1992 to June 30, 1993 with follow-up to June 30, 1995 comprises the managed care population. Note: All years are reported as fiscal years.	• During the study period, the Johns Hopkins School of Medicine represented 54% (N=11,243) of the covered workers. The Johns Hopkins Hospital (JHH) represented 28% (N=5,774) and other entities represented 18% (N=3,952). • Interestingly, although JHH represents 28% of the population at risk, it accounts for nearly half of WC costs – presumably due to needlesticks and sprain injuries that are common among hospital workers. • Costs incurred in 1993 vs. 1990 for the entire Johns Hopkins Medical Institutions (JHMI) and for JHH both decreased by half. ➢ JHMI: 1990: \$2.073M vs. 1993: \$1.012M. ➢ JHH: 1990: \$1.139M vs. 1993: \$564K. <u>Costs savings reported for only the Johns Hopkins Hospital</u> • The greatest costs decreases were in temporary total disability (TTD) payments (from \$445K to \$167K; a decrease of 62%; p value not reported). • Decreased medical costs from \$372K to \$179K were the second largest savings at 52% (p value not reported). • Permanent partial disability (PPD) costs decreased from \$283K to \$175K, or 38% (p value not reported). • As a percentage of costs, the following groups represent the major program expenses: ➢ TTD: 39% in 1990 vs. 30% in 1993. ➢ PPD: 24% in 1990 vs. 32% in 1993. ➢ Aggregate medical costs: 33% in 1990 vs. 32% in 1993. ➢ Other expenses: 3% in 1990 vs. 7% in 1993. This category includes attorney fees and temporary partial disability costs.	After introducing managed care into the Johns Hopkins workers' compensation system, costs decreased by about half. Ninety percent of this reduction is due to reduced compensation for medical, TTD, and PPD costs. Unfortunately, the data presented in this article is descriptive. Inferential statistics would provide additional assurance that the savings are statistically significant. <u>Limitations:</u> • Because this study occurred in an academic medical center, its findings may not be wholly reproducible in the general population. • Demographic and other variables were not reported nor controlled for. • Inferential statistical tests were not performed. • Information regarding sample size was not reported.

Article	Objectives	Study Design	Main Findings	Conclusion
Kenny “Determinants of time lost from workplace injuries: the impact of the injury, the injured, the industry, the intervention and the insurer” *International Journal of Rehabilitation Research* 1994;17(4):333-342.	To identify: • Variables that impact upon the amount of time loss from work in injured or ill workers. • Variables: ➢ Injury variables: mechanism of injury, agency of accident, nature of injury, bodily location of injury, results of injury. ➢ Worker variables: gender, age, marital status, no. of dependent children, award rate of pay, employment status, costs of injury, and use of rehabilitation. ➢ Organization variables: industry type, insurer type, and employer size. • Methods: 3 regression models were developed to assess the contribution of each set of variables to lost time from work. The first model examined injury variables and their effect on lost time. The second model explored the interaction between worker variables and lost time, controlling for injury variables. The third model explored the relationship between organizational variables and lost time, controlling for injury and worker variables.	• Retrospective database analysis. • Setting: New South Wales (NSW), Australia. • Time period: From July 1 1991 to December 31, 1992. • Study population: ➢ Size: N=3,401. ➢ 30.2% female. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Employees in the health, manufacturing, or retail industries. ➢ Employees who worked in the City of Newcastle, the Hunter and upper Hunter regions of NSW. ➢ Had at least 1 week or more lost time from work due to a workplace injury or illness. • Data collection: ➢ Data Source: Work Cover Authority (WCA) of NSW. WCA data include characteristics of workers’ compensation (WC) claims. A secondary data source on employer size came from a commercial database.	Select sample characteristics: • Occupation: 38% laborers, 25.3% tradespersons, 15.9% plant and machine operators. 93.4% were employed full-time and 95.5% were permanent employees. • Mean rate of pay was \$354.28 ± \$165.91; the median rate of pay was \$375.50. • Mean costs: hospital \$465.40 ± \$1531.19; occupational rehabilitation treatment \$238.40 ± \$706.92; physiotherapy treatment \$313.55 ± \$762.36. • 8% of injured workers received rehabilitation from an accredited rehabilitation provider. • Most frequent injury was strain or sprain (54.3%). Regression analyses: • Model 1 examined injury variables. These accounted for 28% of the variance of lost time from work ($p < 0.001$). • Loading variables backward revealed poisoning or toxic effects and back injury accounted for most of the variance. ➢ Poisoning or toxic effect: mean of 30.5 weeks off work. ➢ Trunk injury resulting in partial permanent disability: mean 26.3 weeks off work. ➢ The least time lost from work was due to cuts: mean of 2.8 weeks. • Model 2 examined worker variables while holding injury variables constant. This model accounted for 62% of the total variance, or an additional 34% of variance on top of model 1 ($p < 0.001$).. ➢ Workers receiving rehabilitation had a mean of 3.33 less weeks time off than all other workers controlling for the nature of the injury. ➢ Controlling for the nature of the injury part-time workers (1.9 wks), older workers (0.23 wks), and workers receiving lower rates of pay (1 wk) had more time lost. ➢ Every \$1,000 dollars spent on workers for hospitalization, occupational rehabilitation, or physiotherapy added 1 week, 6 weeks, and 3 weeks, respectively to time lost from work by that worker. • The third model, organizational variables, accounted for little overall variance. Separate regression equations for industry type, insurer type, and employer size showed that: ➢ Employer size and insurer type predicted amount of time lost controlling for all other variables. Claimants insured under managed funds lost on average an extra week from work.	The principal hypothesis was that the injury variables would account for most of the variance in time-lost from work for an injured worker. However, based on this analysis, worker variables counted for more variance (34% vs. 28%). As such, this research supports the idea “that injury and injury impact are different. That is, a serious injury may occur without an impact (after physical recovery), and a minor injury may result in a catastrophic impact for the injured worker.” An additional finding was that rehabilitation had a positive effect on reducing the amount of time lost (by 3.3 weeks). Yet, a conflicting result indicates that the more one spends on rehabilitation the longer one is off work, even when controlling for other factors. The finding that certain groups (e.g., elderly, lower paid, etc.) have more time off work due to injury suggests that these more “vulnerable groups” may profit from targeted occupational intervention after injury. Limitations: • Time lost following injury was the only impact variable measured. Other impact variables (e.g., psychological stress) may have also played a role in preventing return to work.

Article	Objectives	Study Design	Main Findings	Conclusion
Kyes *et al*. "Employer satisfaction with Workers' Compensation health care: results of the Washington State Workers' Compensation managed care pilot" *Journal of Occupational and Environmental Medicine* 2003;45(3):234-240.	To report: • Employers' satisfaction with the quality of medical care received by employees in a workers' compensation (WC) managed care pilot program (MCP). • Employers' satisfaction with employee health outcomes in a WC MCP program. • The quality of communication between employers, providers, and claims adjudicators in a WC MCP program. The MCP was organized around an occupational medicine model that emphasized physician-employer communication regarding medical treatment, time loss status, job modification, and timely return to work. Two changes addressed by the MCP were: (1) the method of payment at the plan level; and (2) the delivery of care at the clinic level. The former changed from a fee for service (FFS) system to an experience-rated capitation system. The latter changed from a traditional office-based FFS model to an occupational medicine model.	• Telephone survey. • Setting: 8 counties in Washington State. • Time period: Not reported. • Study population: ➢ Size: N=146 for control group and N=97 for MCP firm. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All firms that experienced at least 1 work-related injury during the evaluation period were eligible for inclusion. • Data collection: Telephone. The survey was developed and validated by researchers. Inclusion items were based on discussions with employers, claims adjudicators, health care providers, and Department of Labor and Industry (DLI) administrative staff. The instrument was pre-tested on a sample of firms in Washington state and demonstrated good internal reliability (Cronbach's α = 0.71 to 0.87). Results are reported The results are based on the employer perspective of two groups: (1) employers who used a WC MCP program (MCP); and (2) employers who used the traditional WC program (or control group).	Use the following interpretation: "MCP firms …" means "Employers who used MCP firms … vs. employers used traditional WC care firms." <u>Satisfaction with treatment</u> • MCP firms have higher levels of satisfaction for medical treatment ($p < 0.05$) and for receiving treatment information ($p < 0.01$) than control firms. • There was no statistical difference between MCP and control firms in: ➢ Rating of time to treat workers. ➢ Whether the injured worker was seen on the day of injury. ➢ Whether the employer received treatment information from provider. ➢ Appropriateness of medical expenses covered. <u>Time loss</u> • For return to work (RTW) time, MCP firms were rated excellent in returning employees to work quicker than were control firms (63% vs. 35%; $p < 0.01$), however for a good rating, control firms had a better outcome than MCP (32% vs. 22%; individual p value not reported). • MCP firms received higher quality information from health care providers than control firms. • With regard to quality of loss time information, only the "excellent" response was higher for MCP vs. control (68% vs. 21%; $p < 0.01$). <u>Work modifications</u> • MCP firms were more likely to report workers being placed on modified work duty (30% vs. 18%, $p = 0.07$) than control firms. • Ability to accommodate work modifications was difficult in 5% of MCP firms vs. 14% in control firms ($p = 0.06$). • MCP firms had more favorable perceptions regarding injured worker ability to perform their jobs after returning to work. <u>Claims processing</u> • MCP firms were more likely to be happy with claims processing than control firms (58% vs. 31%; $p<0.001$). • WC administrative processing was higher for MCP firms than control firms as judged by responses on the excellent category (37% vs. 22%; $p < 0.01$). <u>Overall satisfaction with the current WC system</u> • No difference in employers' perceptions of workers' satisfaction between MCP and control firms. • MCP firms had a positive experience within the past three months vs. control firms.	Results suggest that employers using MCP firms were more satisfied with WC care than employers who used control firms. In general, employers of workers in the MCP group received more feedback from providers about the injured worker's condition and treatment. These actions may have important implications for workers themselves, "in that employers who are supportive of treatment administered to an injured worker may also be more supportive when time off from work or work modifications are deem medically necessary." Indeed, MCP firms were more likely to accommodate modified work duty than control firms. Administrative processes in the MCP group were favored over the control group, especially with regard to payment. This may be due to better training among MCP workers with regard to occupational health procedures in submitting claims and assessment forms. Indeed, physicians trained in occupational medicine are more likely to be "attentive to the need to document exposure and work-[related] injuries more thoroughly." <u>Limitations:</u> • Small sample size. • Potential for recall bias.

<table>
<tr><th>Article</th><th>Objectives</th><th>Study Design</th><th>Main Findings</th><th>Conclusion</th></tr>
<tr><td>Kyes et al.

“Evaluation of the Washington State Workers’ Compensation managed care pilot project I”

Medical Care

1999;37(10):972-981.</td><td>To examine:
• The effect of managed care on medical outcomes and patient satisfaction as part of an evaluation of the Washington State Workers’ Compensation managed care pilot.

This study evaluated the experiences of workers receiving care for occupational injuries / diseases through a managed care (MC) workers’ compensation (WC) program as compared to traditional fee-for-service (FFS) programs. The intervention in this study involved changing:
• The method of payment at the plan level from the Department of Labor and Industry FFS schedule to experience-rated capitation.
• The delivery of care at the clinical level from seeing “any doctor” to seeing a physician trained in the occupational-medicine model. This model “emphasizes care coordination and ongoing follow-up aimed at getting the injured worker back to work in a timely manner.”</td><td>• Retrospective cohort.
• Setting: Eight county area in Washington State.
• Time period: April 1995 to March 1996.
• Study population:
➢ Size: N=1,302 at 6 weeks post injury and 372 at 6 months post injury.
➢ Ranged from 22 – 25% female depending on which group and at which time point.
➢ Mean age: 35 ± 11 years at six weeks post injury; 38 ± 11 to 41 ± 12 years at 6 months post injury.
➢ Race: 81% white at 6 weeks post injury; 38 ± 11 to 41 ± 12 at 6 months post injury.

<u>Outcome measures:</u> 6 outcome areas were assessed: (1) general health perceptions; (2) freedom from bodily pain; (3) general mental health; (4) role limitations; (5) level of physical functioning; and (6) upper-body mobility. Measures (1) through (5) were assessed with the Short-Form Health Survey (SF-36) and measure (6) was assessed with the Health Assessment Questionnaire (HAQ). Both used a 0-100 point scale.

<u>Satisfaction measures:</u> 5 areas were assessed: (1) overall treatment; (2) attending physician; (3) overall access to care; (4) access to attending physician; and (5) access to specialist care.</td><td><u>General characteristics</u>
• The intervention (i.e., managed care) group was similar to the control group (FFS) in most baseline characteristics including: race, sex, marital status, self-reported severity of injury, and general assessment of health. The only significant differences were income at 6 weeks and 6 months post-injury.

<u>Medical outcomes</u>
• There was little “meaningful difference” between intervention and control measures in patient outcomes at 6 weeks.
➢ The overall difference in outcome of 0.2 on a 5 point scale was statistically significant with the control group doing better than the intervention group (3.7 vs. 3.5; $p < 0.01$).
➢ The SF-36 “was designed to detect a 3 point difference in scale measures” to represent clinical significance. None of the domains measured by the SF-36 met this threshold.
➢ The authors note that in this study, differences of less than five points “would not generally be viewed as clinically important.”
• There was little change in differences in outcome scores at six months. None of the domains were significantly different between the control and intervention group.
• Multivariate tests of group significance at 6 months showed no significant overall-treatment effect.

<u>Patient satisfaction</u>
• Results at 6-weeks post injury showed that control (FFS) patients were more satisfied with their treatment than intervention (MC) patients (51% vs. 47%; $p < 0.01$). FFS patients had higher satisfaction in all categories (i.e., overall treatment, attending physician, overall access to care, access to physician of choice, and access to specialists).
➢ Satisfaction among MC patients was lowest with regard to overall access to care (37% vs. 43%; $p < 0.001$).
• At 6 months overall treatment satisfaction decreased in both groups. However, satisfaction remained statistically significantly higher ($p < 0.05$) in FFS for overall access to care, access to physician of choice, and access to specialists.</td><td>In general, both MC and FFS workers’ compensation patients had low levels of satisfaction with their care. However, in comparison to one another, MC workers’ compensation patients had significantly lower satisfaction on all measures at 6 weeks and most measures at 6 months.

It is conceivable that at 6 months, patients still receiving treatment in both groups would have similar levels of satisfaction. Yet, the results show that access to care, access to physician of choice, and access to specialists results in lower satisfaction in the MC group. This dissatisfaction could be a proxy for the relative importance attached to accessibility attributes for the patient. Furthermore, any re-design of a WC payment structure should incorporate appropriate access issues to improve patient satisfaction.

<u>Limitations</u>:
• The results of this study are specific to Washington State and may not be generalizable to other states or settings.
• Limited sites for occupational clinics were available, thus some workers in MC had to travel considerable difference to be treated. This could result in reduced satisfaction.</td></tr>
</table>

Article	Objectives	Study Design	Main Findings	Conclusion
Lemstra and Olszynski "The effectiveness of standard care, early intervention, and occupational management in Workers' Compensation claims" *Spine* 2003;28(3):299-304. (See follow-up review for Lemstra and Olzsynski in *Spine* 2004;29(4):1573-1579.)	To determine if an occupationally based program, as compared to a standard program or an early intervention program, would have a substantial effect on: • Injury claim incidence. • Duration. • Costs. Two companies were used in this study: (1) Company A was in the meat industry. It did not have direct access to an early intervention program (IEP). It only had access to standard care and physical therapy; and (2) Company B was located in the same province, had a similar industry code as company A, and had direct access to the provincial EIP program. Both companies were of similar size, worked similar hours, and performed similar functions. Three programs were assessed in this study: (1) Standard medical and physical therapy care; (2) an early intervention program (EIP) care which provided rapid and expanded rehabilitation services to injured workers immediately after injury; and (3) occupational management strategies to prevent injuries in the workplace (e.g., shift rotations, reduced lifting loads, and ergonomic changes in daily work activities).	• Retrospective and prospective cohort. • Setting: Saskatchewan, Canada. • Time period: Claims from 1999 through March 31, 2001. • Study population: ➢ Employees in company A: 185 (1999) and 285 (2000). ➢ Employees in company B: 232 (1999) and 232 (2000). ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All claims from 1999 through March 31, 2001 were included. • Data collection: Not reported. There were three distinct comparisons in this study: (1) Standard care (1999) in company A vs. EIP in company B (1999); (2) OMP (2000) in company A vs. standard care (1999) in company A; and (3) OMP (2000) in company A vs. EIP (2000) in company B. For comparison (2), company A company initiated an occupational management protocol (OMP) designed to change work processes to reduce injuries. Statistical comparisons were not reported in this article.	<u>Standard care (Company A, 1999) vs. EIP (Company B, 1999)</u> • Time loss <u>claims</u> (incidence) per 100,000 hours worked for upper extremity and back injury for company: ➢ A: 2.3 vs. 2.6, respectively. ➢ B: 7.3 vs. 4.0, respectively. • Total <u>days</u> lost per 100,000 hours worked for upper extremity and back injury claims for company: ➢ A: 138.5 vs. 60.9, respectively. ➢ B: 731.6 vs. 141.0, respectively. • Compensation costs per 100,000 hours worked for upper extremity time-loss claims and back injury time loss claims for company: ➢ A of $15,777 vs. $8,713, respectively. ➢ B of $80,816 vs. $12,296, respectively. <u>Standard care (Company A, 1999) vs. OMP (Company A, 2000)</u> • Time loss <u>claims</u> (incidence) per 100,000 hours worked for upper extremity and back injury were reduced to: ➢ 0.6 and 0.6, respectively (RR: 0.28; 95% CI: 0.07 – 1.09 and RR: 0.25; 95% CI: 0.07 – 0.93, respectively). • Total <u>days</u> lost per 100,000 hours worked for upper extremity and back injury claims were reduced to: ➢ 12.3 and 1.1, respectively (RR: 0.09; 95% CI: 0.07 – 0.12 and RR: 0.02; 95% CI: 0.01 – 0.04). • Compensation costs per 100,000 hours worked for upper extremity time-loss claims and back injury time loss claims were reduced to: ➢ $597 and $287, respectively. <u>OMP (Company A, 2000) vs. EIP (Company B, 2000)</u> • Company B did not "share the same claim experience from 1999 to 2000" as did Company A, thus making comparisons difficult. However, after adjustment the OMP had a statistically significant effect in lowering both incidence rate of total time-loss upper extremity and back injury claims in comparison to EIP ($p < 0.01$ for both). <u>Claims closure (Company A, OMP, 2000 and Company B, EIP, 2000)</u> • For the EIP physical therapist involvement, neutral or adversarial relationship between employer and WC representative, injury severity, and chiropractor involvement delayed claim closure time: • For the OMP, only injury severity was a predictor of delayed claims closure (RR: 1.68; 95% CI: 1.05 – 27.20), yet the large 95% CI range indicates extreme variability.	Of the three interventions, EIP is the most costly and time consuming and has the least positive results. This result is not surprising and has been confirmed by other studies. "It is presumed that aggressive referral to expanded physical therapy might have resulted in the treatment of many workers [who] would have recovered more quickly without the enhanced intervention. As such, many workers had [to delay RTW] plans to complete their 6- to 10-week work hardening and conditioning programs before reintroduction into the work environment." In addition, "rapid and enhanced physical therapist involvement is more likely a predictor of delayed claim closure than a result of it." On the other hand, OMP, seems to provide reduced incidence of claims and reduced total days off claims, as well as reducing costs of these claims. <u>Limitations</u>: • Increased administrative costs due to OMP initiation were not considered. These would likely offset some of the savings enjoyed under the OMP program. • Information on patient satisfaction with the OMP was not assessed. • Inability to randomize the companies and/or employees to either the intervention or control groups.

Article	Objectives	Study Design	Main Findings	Conclusion
Lemstra and Olszynski "The effectiveness of standard care, early intervention, and occupational management in Workers' Compensation claims" *Spine* 2004;29(14):1573-1579. (Note: This is a follow-on study to the previous study by Lemstra and Olsznski.)	To compare the effectiveness of standard care, early intervention treatment, and occupational management in the management of workers' compensation. Three companies were assessed with different interventions over a 3 year time period (ranging from 1998 to 2002): (1) Company A: In 1999 company A had standard care, was switched to occupational management (OM) in 2000, and then switched to the early intervention protocol (EIP) in 2001. (2) Company B: From 1999 through 2000 company B used EIP. In 2002 it used a combination of EIP and OM. (3) Company C: In 1999, 2000, and 2002, the type of care company C used was "not available;" in 2001 it used standard care. Three three types of care used in this program were: (1) Standard medical and physical therapy care; (2) an early intervention program (EIP) care which provided rapid and expanded rehabilitation services to injured workers immediately after injury; and (3) occupational management strategies to prevent injuries in the workplace (e.g., shift rotations, reduced lifting loads, and ergonomic changes in daily work activities).	• Retrospective and prospective cohort. • Setting: Saskatchewan and Alberta, Canada. • Time period: Claims from 1999 through 2002. • Study population: ➢ Sample size: not reported. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Data collection: Not reported. There were three distinct comparisons in this study: (1) OM in company A in 2000 vs. EIP in company A in 2002; (2) EIP in company B in 2000 followed by EIP/OM in company B in 2002; and (3) EIP in company B in 2001 vs. standard care in company C in 2001.	• Note: All changes are per 100,000 hours worked • OM in company A (2000) vs. EIP in company A (2002): ➢ Claims incidence increased from 2000 to 2002 for upper-extremity disorders (UED) from 0.6 to 3.6; back claims increased from 0.6 to 1.5. ➢ Total days lost increased from 12.3 to 225.4 days for UED claims and from 1.1 to 95.8 days for back claims. ➢ Total costs increased from $597 to $29,182 for UED claims and from $287 to $10,011 for back claims. • EIP in company B (2000) vs. EIP/OM in company B (2002). ➢ Incidence for UED decreased from 8.9 to 3.0 while back claims decreased from 5.4 to 3.8. ➢ Total lost days decreased from 662.6 to 253.7 for UED claims and from 280.1 to 90.4 days for back claims. ➢ Total costs decreased from $73,136 to $33,986 for UED claims from $29,737 to $9,084 for back claims. • EIP in company B (2000) vs. standard care in company C (2001). ➢ Incidence for UED and back claims in company B was 8.8 and 4.6 while incidence for these same injuries were 0.3 and 0.3 for company C. ➢ Injury claim duration for UED and back claims in company B were 664.3 and 387.3 days worked vs. 0.9 and 0.3 days in company C. • OM resulted in lower injury claim incidence, duration, and costs than EIM.	The occupational management approach appears to provide better health outcomes than early intervention or standard care. The authors recommend "an occupational management approach, in comparison to early intervention treatment and standard care, be considered for management of occupational injuries. *<u>Limitations:</u>* • Limited time frame of study for specific interventions, typically lasting only 1 year. • Limited injury pool. • Highest cost savings are expected to occur in the first year of OM, thus a one-year study may not accurately reflect long-term trends.

Article	Objectives	Study Design	Main Findings	Conclusion
Lincoln *et al*. "Impact of case manager training on worksite accommodations in Workers' Compensation claimants with upper extremity disorders" *Journal of Occupational and Environmental Medicine* 2002;44(3)237-245.	To determine: • Whether a 2 day training program on integrated case management (ICM) was associated with actual changes in case management practice patterns regarding the recommendation, pattern, and implementation of workplace accommodations: • The most common types of accommodations implemented and differences. • The distribution of accommodation types between those trained and not trained in ICM. <u>Intervention:</u> Nurses were randomly selected to receive integrated case management training in: (1) conducting ergonomic assessments; (2) using ergonomic evaluations as the basis for implementing workplace accommodations; (3) training claimants to reduce barriers that prevent return to work (RTW); and (4) maintaining a focus on coordinating care. ICM training included 16 hours of workshop training and consisted of how to conduct a comprehensive initial interview, develop a case management plan, apply problem solving practices, assess work-site ergonomics and provide ergonomic accommodations.	• Prospective randomized controlled investigation. • Setting: Statistical metropolitan areas across the United States. • Time period: Not reported. • Study population: ➢ Size: N=101 (N=53 intervention group and N=48 in control group). ➢ 74% female. ➢ Mean age: 49.7 ± 8.7 years. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Single claims with no previous claim within the past two years. ➢ Claimants having one or more of the following ICD-9 codes: 353, 354, 715, 723, 726-729. 840. ➢ Only cases accepted within 30-90 days from the initiation of lost work time. • Data collection: ➢ Demographics were collected using the US Department of Labor's Office of Workers' Compensation (OWCP) Automated Claimant Information Management File. ➢ Data on accommodation were extracted from nurse progress reports. ➢ Implementation status was coded from nurses reports.	<u>Participant characteristics</u> • There were no significant group differences (i.e., control vs. intervention) in gender, number or type of upper extremity diagnoses, agency of employment, geographical region, days to adjudicate claim, or percentage of controverted claims. • Volunteers in the intervention group were older than those in the control group (46.5 ± 8.5 years vs. 44.6 ± 8.8 years; p = 0.014). • The majority of claimants (60%) had a diagnosis of mononeuritis of the upper extremity, which was typically carpal tunnel syndrome. <u>Accommodation characteristics</u> • 208 accommodations were recommended and 74.5% (N=155) were implemented. • ICM (i.e., the intervention) nurses recommended 2.43 accommodations on average per claimant vs. 1.63 for usual care (i.e., the control) nurses (p < 0.01). • ICM nurses were 1.4 more times than usual care nurses to have accommodations implemented (1.81 vs. 1.25 average accommodations per claimant implemented; p < 0.05). • On average, ICM nurses recommended more accommodations per claimant than usual care nurses: ➢ 70% of ICM claimants received 2 or more recommendations vs. 44% for UC claimants (p < 0.01). ➢ 25% of ICM claimants received 4 or more recommendations vs. 10% for UC claimants (p = 0.05). • For implementation, ICM claimants had two or more accommodations implemented 47% of the time whereas only 31% of usual care claimants had two or more accommodations implemented, but this was not statistically significant (p < 0.10). • Most common type of accommodations were: ➢ Administrative in nature (55%). ➢ Lifting restrictions (recommended 34 times). ➢ Modified / light duty (recommended 46 times). • Administrative accommodations were more likely in the usual care group than the ICM group (73% vs. 43%; p < 0.001). ICM claimants were more likely to receive recommendations to improve seating posture, modified workspace, and computer adaptations.	ICM training appeared to have an impact on the amount of accommodations requested for injured workers when compared to usual care. Yet, the implementation rate for the two groups, while statistically different, was similar for both groups (1.81 vs. 1.25 implementations for ICM and usual care, respectively). ICM nurses recommendations, however, appeared to be "more diverse and addressed a variety of potential ergonomic solutions that seem to reflect the specific training received by this group." This study did not address the particular barriers to accommodation (e.g., cost, inadequate demonstration of effectiveness, complexity, and support for implementation). <u>Limitations:</u> • Certain accommodations could have been implemented after the final reports were submitted, thus improving the overall implementation rates. • Data were derived from clinical nurse reports, not direct observations. • Nurses in the ICM group were aware of the goals of the study and that workplace accommodations would be reviewed in the future.

Article	Objectives	Study Design	Main Findings	Conclusion
Linz *et al*. "Care management of work injuries: results of a 1-year pilot outcome assurance program" *Journal of Occupational and Environmental Medicine* 2001;43(11):959-968. This study envisioned a care management program (called the Outcome Assurance Process) "that would manage and direct the care of injured workers contemporaneously with the deliver of care to ensure early, safe, and enduring return to work."	The objectives of this study are to: • Refine the methods of the care management process. • Evaluate the ability to manage and eliminate usual delays associated with return to work (RTW). • Compare these RTW outcomes with established RTW benchmarks. Features of this program included: coordinated communication, documented care, and computerized outcome tracking organized by a clinically experienced nurse with an understanding of workers' compensation and local health care providers. Three areas were identified that showed the greatest opportunities for improved outcomes: (1) Administrative: Features reduced administrative delays and emphasizes timely, accurate, and complete communication. (2) Patient care: Uses a sports medicine approach featuring an early diagnosis to enable aggressive and effective treatment. (3) RTW management delays: Features direct communication with employee supervisors to determine RTW functions.	• Prospective cohort. • Setting: Northeast Cincinnati, OH. • Time period: October 1, 1999 – September 30, 2000. • Study population: ➢ Size: N=608 ➢ 21% female. ➢ Mean age: 34.4 years. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ All workers employed in companies who agreed to participate in the program who had injuries and were initially seen at a hospital-managed occupational managed care (OMC) center or emergency department. • Study information: Details of the Outcome Assurance Process are described on pages 960 – 963. • Data collection: Not reported. LMB: Loosely managed benchmarks. This term denotes usual care for injured workers. WMB: Well-managed benchmarks. This term denotes optimal case management outcomes for sustained RTW for 266 designated primary ICD-9 codable diagnoses modified by manual classification. LWD: Lost workdays per case.	<u>General study information</u> • 608 workers were seen for initial evaluation and treatment of work-related injuries. Of these, 96.8% (N=589) had a final ICD-9 diagnosis available. There were 163 different diagnoses. • The five most prominent diagnoses included: ➢ Open wound, finger (N=90). ➢ Lumbar, sprain or strain (N=62). ➢ Lumbo-sacral, sprain or strain (N=62). ➢ Cornea abrasion (N=32). ➢ Foreign body abrasion (N=32). • Delays in appointment scheduling were minimal. 2/3 of the 42 patients referred to specialty care were seen within 2 days. The maximum delay in specialty referral was 8 days. • In keeping with the sports medicine approach, the number of active visits for rehabilitation was minimized by emphasizing active therapy to build strength and mobility. <u>Comparison of actual RTW outcomes to benchmark RTW</u> • 97.7% (N=418) of cases with one of 266 ICD-9 codes identified by the Ohio Bureau of Workers' Compensation (OBWC) for management had RTW data. The other ten cases did not RTW for reasons unrelated to the injury. • Total number of days to RTW or to modified-RTW was 2,137 (mean, 6.99 ± 7.64 days). ➢ The actual RTW outcome was 36.6% of the LMB (3,702 days less than the LMB), or 8.9 mean less days. ➢ The actual RTW outcome was 73.1% of the WMB (785 days less than the WMB) or 1.9 mean less days. ➢ All differences are statistically different at $p \leq 0.05$. • The financial value of saved lost workdays, when valued at $200 per workday are: ➢ $740,400 for the 3,702 days saved compared to LWB. ➢ $157,000 for the 785 days saved compared to WMB • The total release to return to regular or modified work was 652 days (mean 1.69 ± 11.6 days). • The top five barriers to and reasons for delay in RTW include: work scheduling issues (36.4%, N=39), employer issues (24.3%, N=26), other (15.9%, N=17), provider issues (8.4%, N=9), and family/social issues (5.6%, N=6). • 4.6% (N=19) of cases met the definition of "poor RTW:" ➢ Total LWD was 1,204 days or a mean of 63.4 per case. ➢ Two cases had catastrophic injury accounting for 41.5% of lost workdays. ➢ In 5 cases employer issues were the problem (i.e., "inability or unwillingness to provide modified work").	This study showed that combining efforts of an occupational health delivery system with case management services could together provide "care" management to the injured worker, improve health outcome, and improved RTW speed. Results were compared to two sets of benchmarks: (1) regular care; and (2) optimal care. The care management approach envisioned by the Outcome Assurance Program provided results that exceeded both the regular and optimal benchmark standards. <u>Limitations:</u> • This study was unable to identify the critical components of the care management and RTW process.

Article	Objectives	Study Design	Main Findings	Conclusion
McGrail *et al*. "A comprehensive initiative to manage the incidence and cost of occupational injury and illness" *Journal of Occupational and Environmental Medicine* 1995;37(11):1263-1268.	To determine: • If a comprehensive medical management initiative towards workers' compensation is successful in a university-based preferred provider organization (PPO). This program occurred at the Johns Hopkins Workers' Compensation Program (JHWCP) in Baltimore, MD. The purpose of this program was to increase efficiency, outcomes, and return-to-work (RTW) times for injured workers. Key measures of the plan included patient advocacy, customer service, physician care by a small network of physicians, case management, close follow-up, and dialogue between all parties regarding claim management. Key aspects of the program included early reporting, patient advocacy, care facilitation, and preventative measures to help injure workers return to work. All findings are discussed in fiscal years that run from July 1 to June 30 each year (e.g., FY 1992 runs from July 1, 1991 to June 30, 1992).	• Longitudinal cohort. • Setting: Academic institution in Baltimore, MD. • Time period: 1992 and 1993 (note: 1992 is the baseline year). • Study population: ➢ Size: N=884. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Inclusion/Exclusion: ➢ All injuries or illness resulting in lost time or that required treatment and were reported to the workers' compensation (WC) clinic. • Data collection: ➢ All reported conditions were recorded and logged in accordance with Occupational Safety and Health Administration (OSHA) standards. Specifically, the OSHA 200 Log of significant occupational injuries and illnesses was used to record reported conditions. In addition, occupation and location of employment, diagnosis, days lost time, and restricted duty were recorded for further analysis.	• There were 13,895 and 14,297 employees for 1992 and 1993, respectively. • During the study period there were 31.4/1,000 OSHA recordable events. • There was a 23% decrease in the morbidity incidence ratio (MIR) during the study period (MIR: 0.77, 95% CI: = .68 to .88). 491 events (35.3/1,000) occurred in 1992 and 393 events (27.5/1,000) occurred in 1993. The difference was due to a decreased incidence of work-related conditions among hospital workers. ➢ 78.4% (N=385) of incidents in 1992 resulted in lost workdays and 5.5% (N=27) resulted in restricted workdays. ➢ 55.2% (N=217) of incidents in 1993 led to lost workdays (a decrease of 29%; $p < 0.01$). ➢ However, there was a significant increase in lost workdays that resulted in restricted duty in 1993 (N=393; 15%; $p < 0.01$). • A significant increase in fractures occurred, yet a significant decrease in incidence of needle-sticks, contusions, and back sprains was observed. The decrease in needlestick incidence coincides with the initiation of "needleless" system. In addition, a renewed emphasis on reducing sprains and contusions also coincided with the introduction of the new program. • The number of lost days per episode decreased 33% from 10.4 to 6.6 days from 1992 to 1993 ($p < 0.01$). • The number of restricted duty days increased from 0.2 days in 1992 to 1.5 days in 1993 ($p < 0.01$). This represented "the liberal use of this strategy to return employees to work" and represented an increase in days of restricted duty for sprains, contusions, lacerations, and fractures. • Housekeepers, nurses, nursing aides, and coordinators all had decreased days lost and increased restricted duty days in 1993 as compared to 1992. • Multivariate analysis revealed that the change in fiscal year (which is a proxy for introducing the new WC PPO system) remained an independent predictor of lost days ($p = 0.012$) and restricted duty days ($p < 0.01$) even when controlling for occupation. • Overall, medical and indemnity losses for new claims decreased by a total of $187,725 from $0.09 to $0.05 per $100 of payroll. • The overall savings in WC costs from 1992 to '1993 was $543,200.	After program introduction, significant savings in lost days per incident and in medical and indemnity losses per new event occurred. Due to constraints of study design, some of these savings were likely due to increasing awareness among staff of common workplace injuries (e.g., needlesticks and lifting injuries). Regardless, it is likely that "case management made an important contribution to savings." Accordingly, the decrease in injury incidence and lost workdays, albeit indirect measures, are surrogates of work-related morbidity. In addition, there was an increase in the number of restricted duty days used in the study. This represented a "liberal" policy of returning injured workers to work sooner, often times on modified job duty. <u>Limitations:</u> • The changes identified in this study took place in an academic medical center. As such, the availability of expert resources is likely greater than found in the general community. Therefore, these results may not easily translate to the community at large.

Article	Objectives	Study Design	Main Findings	Conclusion
Miller and Levy "Geographic variation in expenditures for workers' compensation hospitalized claims" *American Journal of Industrial Medicine* 1999;35(2):103-111.	To assess: • Interstate geographic variation in hospital expenditure for workers' compensation (WC). Statistical analysis: Total medical and ancillary payments per injury episode were analyzed. For consistency purposes, inpatient physician charges and hospitalization charges were combined. The payment variable was converted to the natural logarithm form because the payment distribution begins at $0 and has a long upper tail. Regression analysis was used to control explanatory variables for expenditures within each injury category. Louisiana generally had the highest payments in the sample, and thus is used as the comparison state. Statistical significance is at α = 0.05 and is evaluated with the F-test. The null hypothesis is that there is no difference among states; if rejected, this implies there is variation in WC expenditure across states. Further analysis seeks to control costs differences among states using explanatory variables of interest (e.g., severity, urban, etc.).	• Retrospective database analysis. • Setting: WC claims in 17 states in the United States. • Time period: Sampling ranges from 1979 – 1988, depending on data supplied by the state. • Study population: ➢ Size: N=35,231 claims. ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Cases are limited to hospitalizations. ➢ Cases are limited to upper and lower fractures, dislocations, other joint ruptures; other upper extremity injuries (e.g., non-fractures, dislocations, or ruptures); and back sprains and strains. ➢ Brain and internal injuries were not analyzed. ➢ Claims with costs beyond the established reserve incurred after 18 months of injury were excluded. • Data collection: Data comes from the Detailed Claims Information (DCI) database of the National Council on Compensation Insurance (NCCI). Insurers report information to the DCI database 6 months after initial injury and annually thereafter until there are no more claims. DCI claims are reopened if unanticipated payments arise after closure.	• The joint F-statistic for state effects is significant ($p < 0.001$), rejecting the null hypothesis that costs are the same across states. The magnitude of cost variations differed across states: ➢ For lower and upper extremity fractures, costs are about 20% lower in FL than LA and range from 30 – 50% lower for CT, MA, MN, and NY than LA (all $p < 0.05$). ➢ For back injuries, costs in NY, CT, and WI are about 15 – 25% lower than LA ($p < 0.05$) while MA, PN, and KY have about 10% higher costs ($p < 0.10$) than LA. • When including complete characteristics (i.e., the full model), variation still remains among states (F-statistic $p < 0.001$): ➢ For upper and lower extremity fractures, costs are at least 70% below LA for CT, FL, IL, PN, NY, and MA ($p < 0.05$) and considerably above LA for KY, ME, and NM. • When included in the full model both personal characteristics and injury variables are jointly significant ($p < 0.001$) and these equations explain considerably more variations in costs. • Based on the results, states have been ranked into high, medium, and low cost states: ➢ High cost states for all three injury categories include: GA, KY, LA, and ME. ➢ Medium cost states for fractures and upper non fractures include: MN, OR, VA, WI. ➢ Low cost states for all categories include: CT, IL, MA, NY, and HA. • The results suggest that states with inclusive mandatory rate setting, such as CT, MA, and NY have lower costs. • States with hospital rate setting have between 25 and 40% lower costs ($p < 0.001$) than other states for arm and leg fractures and 40% lower costs ($p < 0.001$) than other states for other upper and back injuries. • States with WC hospital fee schedules had a 5% lower ($p < 0.001$) costs for arm and leg fractures and had about 3% lower costs for other upper injuries ($p = 0.15$).	This study of 17 nationally represented states shows that there is geographic variation in WC hospitalization expenditure even when controlling for potential explanatory variables. This study also shows that specific factors may influence costs. In particular, "mandatory hospital rate setting is associated with lower payments for the period examined." In addition, "[WC] fee schemes, higher percentages of urban population, and regional trauma care centers are also associated with lower injury costs." <u>Limitations</u>*:* • This study is restricted to three types of injuries which may not be representative of other types of services provided by hospitals. • Because WC is the "first dollar provider," it often cannot take advantage of cost containment measures; this may influence the results.

Article	Objectives	Study Design	Main Findings	Conclusion
Miller and Levy "Geographic variation in expenditures for further workers' compensation physician claims" *American Journal of Industrial Medicine* 1997;32(1):27-34.	To examine and determine: • Interstate variations in physician claims cost for injuries paid for by workers' compensation (WC). • Factors that may help explain this interstate variation. Statistical analysis: Total medical and ancillary payments per injury episode were analyzed. The payment variable was converted to the natural logarithm form because the payment distribution begins at $0 and has a long upper tail. Regression analysis was used to control explanatory variables for expenditures within each injury category. Louisiana generally had the highest payments in the sample, and thus is used as the comparison state. Statistical significance is at $\alpha = 0.05$ and is evaluated with the F-test. The null hypothesis is that there is no difference in costs among states; if rejected, this implies there is variation in WC expenditure across states. Further analysis seeks to control costs differences among states using explanatory variables of interest (e.g., severity, urban, etc.).	• Retrospective database analysis. • Setting: WC claims in 17 states in the United States. • Time period: Sampling ranges from 1979 – 1988, depending on data supplied by the state. • Study population: ➢ Size: N=181,741 claims ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Cases are limited to hospitalizations. ➢ Cases are limited to upper and lower fractures, dislocations, other joint ruptures; other upper extremity injuries (e.g., non-fractures, dislocations, or ruptures); and back sprains and strains. ➢ Brain and internal injuries were not analyzed. ➢ Claims with costs beyond the established reserve incurred after 18 months of injury were excluded. Data collection: Data comes from the Detailed Claims Information (DCI) database of the National Council on Compensation Insurance (NCCI). Insurers report information to the DCI database 6 months after initial injury and annually thereafter until there are no more claims. DCI claims are reopened in unanticipated payments arise after closure.	<u>Basic model of medical payments to physicians per episode</u> • The joint F-statistics for all state effects in each of the three injury equations is significant ($p < 0.001$), thus rejecting the null hypothesis that costs are the same across all 17 states. ➢ Upper and lower extremity fractures: Costs are range from below 10 – 20% of LA for FL, GA, NY, PN, and VA and about 30 – 40% lower for KY and MA (all $p < 0.05$) than for LA. ➢ Upper extremity fractures: Costs range from about 12 – 49% less for CT OR, ME, MI, MN, WI, and HI than LA (all $p < 0.05$). ➢ The R^2 value for the three injuries (e.g., arm and leg fracture, upper other, and back) explain only about 10% 10% of variation in costs. <u>Personal characteristics model of medical payments per episode (i.e., controlling for personal and injury variables)</u> • The F-statistics for variation in all states increases in magnitude with the addition of personal and injury covariates for each injury category (all $p < 0.05$). • The authors only report results of the state indicator and state characteristics variable. However, results for the year indicator, personal characteristic, injury characteristic, and severity variables are statistically significant ($p < 0.05$). • Equations in this model explain more of the cost variability based on a higher R^2 of 0.34, 0.20, and 0.26 for arm/leg, upper other, and back, respectively. • The magnitude of variation is similar to the first model, except that it nearly doubles for NY (from around –0.20 in model 1 to –0.45 in model 2). <u>Complete model: personal , injury, and state characteristics added</u> • The joint F-statistics for all state effects are statistically significant for all three injury types (all $p < 0.001$). • The R^2 value does not increase much, most state characteristics are statistically significant. • Specific findings that change costs after adding state characteristics include: ➢ % of population living in urban areas in all but the fractures equation decreases costs ($p < 0.05$). ➢ Regional trauma care decreases costs except for backs ($p < 0.05$). ➢ % of population in HMOS and percent of physicians who are general practitioners decreases costs for upper and lower extremities ($p < 0.01$) but increases costs for back injuries ($p < 0.01$).	There is substantial interstate variation in physician costs for treating injured workers by WC payment. Specific factors related to lower costs include: high percentage of urban population, regional trauma care centers, presence of HMOs, and a higher percentage of general practitioners practicing in a given region. <u>Limitations</u>*:* • The sample is restricted to three types of injury. • The payment source may influence the ability to generalize results to areas not covered by WC payments. • This study examined state level variations which may not accurately represent local market cost variations (e.g., intra- or inter-city variations). • This model may be sensitive "to the inclusiveness of injury category."

Article	Objectives	Study Design	Main Findings	Conclusion
Rudolph *et al*. “What do injured workers think about their medical care and outcomes after work injury” *Journal of Occupational and Environmental Medicine* 2002;44(5):425-434.	To assess: • Patient satisfaction with medical care and patient perceptions of health and functional outcome after work injury. The California Division of Workers’ Compensation (WC) contracted with the University of California, Berkeley Survey Research Center to develop a standardized self-administered questionnaire to collect data on patient satisfaction and outcomes among Californian Workers’ Compensation claimants. The final survey had five domains: (1) post-injury health and functional status; (2) patient reports and evaluation of care; (3) utilization of medical services; (4) return to work; and (5) demographic and occupational characteristics of injured workers. MD = medical doctor. DC = doctor of chiropracter. PA = physician’s assistant. NP = nurse practitioner.	• Convenience survey. • Setting: California. • Time period: July 1, 1997 through December 30, 1997. • Study population: ➢ Size: N=813. ➢ 63.5% female. ➢ Mean age: 41.4 years. ➢ Race: 48.6% white. • Eligibility / Inclusion: ➢ Injured workers covered by one of four WC health organizations (pg. 427). ➢ Injured during the specific time period above. ➢ Had 3 or more days of lost time or received payment for temporary disability. ➢ Used medical services with total costs of more than $2,500. • Study information: The initial survey was sent out as a pilot to 800 workers’ compensation claimants. Based on data collection and feedback the final survey was completed from February 1998 through July 1998. • Data collection: Data was collected from participants by way of telephone interview. Up to 10 attempts were made to contact each individual. • Data analysis: Descriptive and univariate analyses were performed. Data responses were dichotomized for data analysis.	<u>Descriptive analyses</u> • Access and utilization: ➢ 13.3% of workers reported some or a lot of trouble getting medical care. ➢ < 20% of patients saw only one doctor whereas 25% saw 5 or more different doctors. ➢ 22% made ≥ 25 visits; 45% < 10 visits. ➢ MDs provided most care (63%), physical therapists 15%, DCs 6.5%, and 2% by PA or NP. • Non-compensated medical costs: ➢ 15.7% paid < $99 in non-reimbursed care, 5.7% paid between $100 to $499, and 1.9% paid > $500. ➢ 42% of patients used sick or vacation leave to cover time off from work. • Satisfaction and patient ratings of care: ➢ 23.5% (N=190) of patients reported somewhat or dissatisfied care while 76.5% (N=619) reported somewhat or very satisfied care. • Patient reports on provider behavior: ➢ One third reported they were involved very little or not at all in decisions about their medical care. • Return to work experience: ➢ 94% of respondents worked during their injury. ➢ 44% of workers returned to work “too soon.” ➢ 38% had job change accommodations and 79% of those who changed jobs were satisfied. • Pain and functional outcomes after injury: ➢ 57.6% of workers said the injury had “some” or a “big” effect on life today; 59% still see room for improvement. ➢ 12.9% report constant pain frequency after the injury and 17.2% report pain frequency “almost everyday.” 27.6% report no pain. ➢ Pain interference with life: all the time (12.6%), some of the time (51.1%), and none (21%). <u>Multivariate analyses</u> Three forward stepwise regression models were used: • Model 1 (Satisfaction and non-satisfaction variables): Satisfaction with provider choice (OR: 15.7; $p < 0.01$), high doctor/patient interaction (OR: 5.1; $p < 0.01$) and good functional outcome (OR 1.6; $p = 0.03$) were associated with general satisfaction. • Model 2 (Satisfaction only): Results were similar to model 1. • Model 3 (Non-satisfaction only): Back injury type was negatively associated with general satisfaction (OR 0.6; $p = 0.03$).	This study obtained patient satisfaction information from injured WC workers to determine how satisfied they are with their care. According to the authors “this introductory exploration suggests that injured worker satisfaction with care is rooted in the experience of care, interactions with the health professionals, and perceived outcomes.” Data from this study, for the most part are descriptive and simply paint a picture of the current state of satisfaction. Statistical inference tests were not conducted. Multivariate analyses were conducted. However, details of this statistical test were lacking. Therefore, the results should be viewed as preliminary at best. They may, however, be used as a guide when designing further WC patient satisfaction surveys. <u>Limitations:</u> • Convenience sample was used. • Control group not used.

Article	Objectives	Study Design	Main Findings	Conclusion
Tate "Workers' disability and return to work" *American Journal of Physical Medicine and Rehabilitation* 1992;71(2):92-96.	To assess: • Factors associated with the return to work (RTW) status of injured workers.	• Retrospective study. • Setting: Michigan. • Time period: Injuries occurring between January 1985 to January 1986 and reviewed between January and June 1986. • Study population: ➢ Size: N=200. ➢ 47.5% female. ➢ Mean age: 43.8 years. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Only blue collars employees working on an assembly line job at a large automobile manufacturer were included. • Study information: Four cohorts of N=50 were formed: ➢ Workers who received vocational rehabilitation (VR) services and who eventually RTW. ➢ Workers with VR who did not RTW. ➢ Workers without VR who RTW. ➢ Workers without VR and who did not RTW. • Data collection: ➢ Information was obtained from reviewing personnel and medical files. ➢ Types of data collected: demographic characteristics, injury / disability type and severity, WC benefits, medical and vocational intervention, work status, and wages and costs to the employer.	<u>Job characteristics of workers</u> • The following worker characteristics were associated with workers who RTW vs. those who did not RTW: ➢ Significantly younger (40.2 vs. 47.3 years; $p < 0.01$). ➢ Had more education (12 vs. 10th grade; $p < 0.04$). ➢ Received higher pre-injury wages ($453 vs. $367; $p < 0.05$). ➢ Had more seniority (15.5 vs. 12.0 years; $p < 0.05$). ➢ Had fewer severe cases (N=21 vs. 40; $p < 0.05$). <u>Differences between the four cohorts</u> • VR/RTW workers had a significantly higher incidence of arm and shoulder injuries as compared to the other groups (χ^2 9.86; $p < 0.01$). • VR/RTW workers had a significantly higher incidence of knee and leg injuries as compared to the other groups (χ^2 7.53; $p < 0.02$). • Among RTW workers, 38.1% had back and neck injuries compared to 57.5% of non-RTW workers. • VR/RTW workers had a higher proportion of myelograms performed than the three other groups ($p < 0.05$). • VR/no-RTW workers had more electromyograms (EMG) performed than the three other groups ($p < 0.01$). • VR/no-RTW workers had a significantly higher incidence of surgery than the other groups ($p < 0.01$). • Workers with less severe injuries were more likely to return to work than those with severe injuries ($\chi^2 p < 0.05$). • There was no difference in severe vs. less severe cases for non-RTW workers (p = NS).	This study provided a retrospective case review of characteristics associated with RTW and vocational rehabilitation status. <u>Limitations</u>*:* • Results may not be generalizable outside of the very specific patient population used. • Regression analysis was not performed.

Article	Objectives	Study Design	Main Findings	Conclusion
Tuchin and Bonello "Preliminary findings of analysis of chiropractic utilization and cost in the Workers' Compensation system of New South Wales, Australia" *Journal of Manipulative and Physiological Therapeutics* 1995;18(8):503-511.	To test a methodology of: • Assessing chiropractic utilization and cost-effectiveness on workers' compensation claimants.	• Retrospective database. • Setting: New South Wales (NSW), Australia. • Time period: July 1, 1992 to June 30, 1993. • Study population: ➢ Size: N=20 for final analysis from a sample of 1,289 possible claims meeting eligibility requirements ➢ Gender: Not reported. ➢ Mean age: Not reported. ➢ Race: Not reported. • Eligibility / Inclusion: ➢ Claims with a chiropractic component. ➢ Only closed cases finalized between July 1, 1992 and June 30, 1993. ➢ NSW was both the state of residence and injury for claimants/ • Data collection: NSW Work Cover Authority administrative database. 1,289 claimants met initial inclusion criteria. From these, 20 were selected at random for the purpose of methodology testing. These cases were analyzed in detail with regard to demographic and injury data in order to ensure proper matching. Additional details of the study methodology can be found on pp. 503-506. Days of work lost (Y), chiropractic payments (Xc), and medical payments (Xm) were collected and tabulated for each of the 20 cases.	<u>General information</u> • No. of compensation days ranged from 5 to 162 (for N=20). • Mean no. days lost from work were 42.1 (for N=20). • Average cost per claim was $3,987.40 (for N=20) and $3,650 (for N=1,289). This is much less than the WCA average of $8,705. The discrepancy is likely due to the exclusion of long-term claims in the sample due to the 1 year inclusion limitation. • In 86% of 1,289 claimants (N=1,147), sprain / strain was the most reported injury. The most commonly effected body part was: ➢ Lower back (57%). ➢ Trunk (13%). ➢ Upper limbs (10%). <u>General trends for the N=20 sample</u> • A trend between chiropractic treatment and days off was noted: ➢ If chiropractic payments were > 60% of the total cost of care, the average days off work was 9.5. ➢ As total payments for chiropractic care decreased < 60% of the total, the number of days off work increased to 50.3. • A general trend between increased medical treatment (as a percentage of the total payment) and increased days off work were seek, however this may be partly due to the small sample and a few outliers. ➢ The two best cases in this trend (as measured by days off work at 5 and 9 days, respectively) had % chiropractic payments of 86% and 100%, respectively. • Chiropractic costs ranged from $25 to $1,450 vs. $0 to $2,556 for medical care.	This retrospective analysis provided a method of cost comparison among chiropractic and medical care. Results from this limited sample indicate trends of cost-effective in chiropractic care vs. medical care with regard to cost and lost days work. Additional studies, using a larger sample population are needed in order to make judgments about the overall cost-effectiveness of chiropractic care vs. medical care. <u>Limitations</u>*:* • Small sample size. • Only trend analyses were reported; statistical comparisons were not reported. • Additional studies using a larger sample population with additional statistical tests (e.g., logistic regression) should be done.

Article	Objectives	Study Design	Main Findings	Conclusion
Wickizer *et al*. "Controlling Workers' Compensation medical care use and costs through utilization management" *Journal of Occupational and Environmental Medicine* 1999;41(8):625-631.	Specific aims of the study were to: • Examine how often utilization management (UM) denied requests for medical care at the time of admission or restricted length of stay during hospitalization. • Identify the diagnoses and procedures most affected by UM review procedures. • Estimate the cost savings associated with UM review. The following procedures were used to review physician patient care requests: 1. Pre-admission review: Authorized admission and approved a specified number inpatient hospital stay days. 2. Concurrent review: Evaluated and approved requests for additional length of stay (LOS). 3. Case management: Monitored and controlled expenses for high-cost cases. Hospitals and physicians were liable for payment reductions if they failed to obtain proper authorization.	• Retrospective review. • Setting: Not reported. • Time period: 1991 to 1993. • Study population: ➢ Size: N=11,785 reviews on 9,319 patients. ➢ 31.1% female. ➢ Mean age: Not reported. ➢ Race: Not reported. ➢ Inpatient setting: 53.0%. • Eligibility / Inclusion: None identified. • Data source: A large UM firm representing a nationwide sample of workers' compensation patients. • Variables analyzed ➢ Pre-admission review: Requests for denied care; outpatient authorization vs. inpatient authorization; inpatient authorization, inpatient authorization with referral management. ➢ Concurrent review: Percent requested hospital days approved and absolute reduction in requested hospital days. ➢ Cost information: Expected expense of hospital stay or outpatient procedure and the approved amounts for requested care.	Reductions in utilization • 2.1% (N=132) of inpatient (IP) pre-admission requests were denied and 2.7% (N=148) of outpatient (OP) treatments were denied. ➢ 59.8% (N=79) of denied IP care was for spinal surgery cases. • 4.6% (N=286) of patients were authorized for OP treatment instead of IP treatment. • 93.9% (N=31) of patients denied IP treatment were approved for IP treatment after case review. • 66.6% (N=30) of patients denied OP treatment were approved for OP treatment after case review. ➢ 51% of "approvals" were for carpal tunnel syndrome; 12% were for arthroscopic surgery. • Approximately 1/3 of IP hernia or arthroscopy patients were required to have the procedure as an OP. • 33.5% (N=1,949) of IP patients had concurrent review to authorize continued hospitalization: ➢ 52% resulted in reduced days authorized compared to what the attending physician requested for extension. ➢ The mean reduction was 3.6 days for patients with any reduction. • Number of days requested vs. approved for: ➢ Medical conditions: 6.6 vs. 4.3. ➢ Surgical conditions: 3.3 vs. 2.0. • UM was most restrictive in approving spinal operations other than fusion (39 of 100 cases authorized). Estimated cost savings • Admission denials saved an average $11,401 per case. ➢ Denials for spinal surgery other than fusion accounted for $803,000,or 82% of the total saved. • Shifting care from IP to OP saved $3,060 per case. • Denial of OP care saved $3,957 per case. ➢ Denials for carpal tunnel syndrome saved $200K, arthroscopy saved $76K, and knee surgery saved $40K. • Concurrent review saved an average of $1,656. • The total amount saved for concurrent review was ~$3.22M and the total amount save for preauthorization review was ~$2.2M. • UM management for spinal surgery (other than fusion) saved $1.61M and spinal surgery for fusion accounted for $313,400 savings.	UM is one available type of managed care activity. Pre-admission and concurrent review were used to screen requests for medical care. The authors were unable to determine if access denials, or reversed decisions, were clinically warranted. However, the high rate of reversal raises questions about "the sophistication and clinical basis" of the UM review process. UM programs have the ability to generate cost savings for employers and insurers. Decreased utilization due to UM saved $5.4 million, but this does not account for administrative costs imposed on physicians and hospitals after undertaking UM activities. To improve UM results, targeted reviews of patients "at risk" for inappropriate care should be considered rather than a general review all patients. Limitations: • Only 1 UM firm was used in the data analysis. • Most patients were from the south, and regional differences may exist. • Reduced admissions due to sentinel effect were not measured.

Article	Objectives	Study Design	Main Findings	Conclusion
Zwerling *et al*. "Workers' compensation cost shifting: an empirical study" *American Journal of Industrial Medicine* 1991;19(3):317-325.	To determine whether: • An HMO had a higher incidence of work-related treatment than the fee for service (FSS) plan. • Wage replacement costs were higher for HMO members, implying greater length of disability. • Medical costs were higher for HMO members, implying provision of more services.	• Retrospective database analysis. • Setting: Boston, MA. • Time period:. • Study population: ➢ Size: N=217 for FFS and N=129 for HMO enrollees. ➢ 21.7% and 24% female for FFS & HMO enrollees, respectively. ➢ Mean age: 41 ± 12.5 and 37 ± 9.7 years for FFS & HMO, respectively. ➢ Race: Not reported. • Eligibility / Inclusion: Enrollment in the largest FFS or HMO plan sponsored by the employer. • Data collection: ➢ The primary independent variable, health provider (i.e., FFS or HMO), was determined as enrollment at the end of FY 1988. Three endpoints were used during data analysis: (1) incidence of work-related conditions; (2) medical costs; and (3) combined medical and wage replacement costs paid beyond day 45 of injury. Potential confounders include: age, gender, length of service, job category, and anatomical site by frequency and cost. Comparisons between HMO and FFS were done using logistic regression with and without confounder adjustment.	• Incidence of work-related injuries were similar in HMO and FFS plans after logistic regression analysis (p = .209). • Average medical cost (i.e., work related) per enrollee for FFS and HMO plans was $838 and $475, respectively. When unadjusted for covariates this difference was significant at p = 0.008 and when adjusted for covariates significant at p = 0.018. In this sample, therefore HMO work-related medical costs were lower. • Average total costs per enrollee were lower in the HMO plan ($909) than in the FFS plan ($1,388), yet this difference was not statistically significant for either the adjusted or unadjusted analysis (p = 0.063 and 0.077, respectively).	This study found no evidence of WC compensation cost shifting in HMO enrollees with work-related injuries. "Although there may be incentives for HMOs to practice workers' compensation cost shifting, it did not occur in [this] population." The authors also report that "although there was no overall statistically significant difference in average total cost, the tendency is toward a lower average cost among HMO enrollees." Limitations*:* • This study was limited to a single large HMO and may not be typical of HMOs in general. • Characteristics of the work site (e.g., safety record or training of employees) were not taken into consideration.

Appendix B: Diagnostic Groupers Used in This Study

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
719.48	PAIN IN JOINT INVOLVING OTHER SPECIFIED SITES	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
729.81	SWELLING OF LIMB	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
780.2	SYNCOPE AND COLLAPSE	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
780.4	DIZZINESS AND GIDDINESS	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
780.7	MALAISE AND FATIGUE	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
780.9	OTHER GENERAL Symptoms only	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
782.0	DISTURBANCE OF SKIN SENSATION	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
786.5	CHEST PAIN	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
786.50	UNSPECIFIED CHEST PAIN	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
786.52	PAINFUL RESPIRATION	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
786.59	OTHER CHEST PAIN	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
789.0	ABDOMINAL PAIN	Systemic	0000	Systemic - Symptoms only	009	Symptoms, unspecified injury
986	TOXIC EFFECT OF CARBON MONOXIDE	Systemic	0034	Systemic - Inhalation injury	001	Toxic exposure, effects
987.6	TOXIC EFFECT OF CHLORINE GAS	Systemic	0034	Systemic - Inhalation injury	001	Toxic exposure, effects
987.8	TOXIC EFFECT OF OTHER SPECIFIED GASES, FUMES, OR VAPORS	Systemic	0034	Systemic - Inhalation injury	001	Toxic exposure, effects
987.9	TOXIC EFFECT OF UNSPECIFIED GAS, FUME, OR VAPOR	Systemic	0034	Systemic - Inhalation injury	001	Toxic exposure, effects
913.4	INSECT BITE, NONVENOMOUS OF ELBOW, FOREARM, AND WRIST, WITHOUT MENTION OF INFECTION	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
914.4	INSECT BITE, NONVENOMOUS, OF HAND(S) EXCEPT FINGER(S) ALONE, WITHOUT MENTION OF INFECTION	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
916.4	INSECT BITE, NONVENOMOUS, OF HIP, THIGH, LEG, AND ANKLE, WITHOUT MENTION OF INFECTION	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
919.4	INSECT BITE, NONVENOMOUS, OF OTHER, MULTIPLE, AND UNSPECIFIED SITES, WITHOUT MENTION OF INFECTION	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
919.5	INSECT BITE, NONVENOMOUS, OF OTHER, MULTIPLE, AND UNSPECIFIED SITES, INFECTED	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
989.5	TOXIC EFFECT OF VENOM	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
989.9	TOXIC EFFECT OF UNSPECIFIED SUBSTANCE, CHIEFLY NONMEDICINAL AS TO SOURCE	Systemic	0036	Systemic - Poisoning	001	Toxic exposure, effects
992.5	HEAT EXHAUSTION, UNSPECIFIED	Systemic	0046	Systemic - Fluid, acid, base disorders	002	Fluid, electrolyte disorders
368.13	VISUAL DISCOMFORT	Eye, orbit	0100	Eye, orbit - Symptoms only	019	Symptoms, unspecified injury
379.91	PAIN IN OR AROUND Eye, orbit	Eye, orbit	0100	Eye, orbit - Symptoms only	019	Symptoms, unspecified injury
918	SUPERFICIAL INJURY OF Eye, orbit AND ADNEXA	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
918.0	SUPERFICIAL INJURY OF Eye, orbitLIDS AND PERIOCULAR AREA	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
918.1	SUPERFICIAL INJURY OF CORNEA	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
918.2	SUPERFICIAL INJURY OF CONJUNCTIVA	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
918.9	OTHER AND UNSPECIFIED SUPERFICIAL INJURIES OF Eye, orbit	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
921	CONTUSION OF Eye, orbit AND ADNEXA	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
921.0	BLACK Eye, orbit, NOT OTHERWISE SPECIFIED	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
921.1	CONTUSION OF Eye, orbitLIDS AND PERIOCULAR AREA	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
921.2	CONTUSION OF ORBITAL TISSUES	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
921.3	CONTUSION OF Eye, orbitBALL	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
921.9	UNSPECIFIED CONTUSION OF Eye, orbit	Eye, orbit	0107	Eye, orbit - Abrasion, contusion	011	Superficial injury
870	OPEN WOUND OF OCULAR ADNEXA	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.0	LACERATION OF SKIN OF Eye, orbitLID AND PERIOCULAR AREA	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.1	LACERATION OF Eye, orbitLID, FULL-THICKNESS, NOT INVOLVING LACRIMAL PASSAGES	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.2	LACERATION OF Eye, orbitLID INVOLVING LACRIMAL PASSAGES	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.3	PENETRATING WOUND OF ORBIT, WITHOUT MENTION OF FOREIGN BODY	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.4	PENETRATING WOUND OF ORBIT WITH FOREIGN BODY	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.8	OTHER SPECIFIED OPEN WOUNDS OF OCULAR ADNEXA	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
870.9	UNSPECIFIED OPEN WOUND OF OCULAR ADNEXA	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871	OPEN WOUND OF Eye, orbitBALL	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.0	OCULAR LACERATION WITHOUT PROLAPSE OF INTRAOCULAR TISSUE	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.1	OCULAR LACERATION WITH PROLAPSE OR EXPOSURE OF INTRAOCULAR TISSUE	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.2	RUPTURE OF Eye, orbit WITH PARTIAL LOSS OF INTRAOCULAR TISSUE	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.3	AVULSION OF Eye, orbit	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.4	UNSPECIFIED LACERATION OF Eye, orbit	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.7	UNSPECIFIED OCULAR PENETRATION	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
871.9	UNSPECIFIED OPEN WOUND OF Eye, orbitBALL	Eye, orbit	0108	Eye, orbit - Laceration	011	Laceration
802.6	CLOSED FRACTURE OF ORBITAL FLOOR (BLOW-OUT)	Eye, orbit	0110	Eye, orbit - Fracture	014	Skeletal trauma
802.7	OPEN FRACTURE OF ORBITAL FLOOR (BLOW-OUT)	Eye, orbit	0110	Eye, orbit - Fracture	014	Skeletal trauma
940	BURN CONFINED TO Eye, orbit AND ADNEXA	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
940.0	CHEMICAL BURN OF Eye, orbitLIDS AND PERIOCULAR AREA	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
940.1	OTHER BURNS OF Eye, orbitLIDS AND PERIOCULAR AREA	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
940.2	ALKALINE CHEMICAL BURN OF CORNEA AND CONJUNCTIVAL SAC	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
940.3	ACID CHEMICAL BURN OF CORNEA AND CONJUNCTIVAL SAC	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
940.4	OTHER BURN OF CORNEA AND CONJUNCTIVAL SAC	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
940.5	BURN WITH RESULTING RUPTURE AND DESTRUCTION OF Eye, orbitBALL	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
940.9	UNSPECIFIED BURN OF Eye, orbit AND ADNEXA	Eye, orbit	0111	Eye, orbit - Burn	011	Superficial injury
983.0	TOXIC EFFECT OF CORROSIVE AROMATICS	Eye, orbit	0118	Eye, orbit - Chemical splash	011	Superficial injury
983.1	TOXIC EFFECT OF ACIDS	Eye, orbit	0118	Eye, orbit - Chemical splash	011	Superficial injury
983.2	TOXIC EFFECT OF CAUSTIC ALKALIS	Eye, orbit	0118	Eye, orbit - Chemical splash	011	Superficial injury
871.5	PENETRATION OF Eye, orbitBALL WITH MAGNETIC FOREIGN BODY	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
871.6	PENETRATION OF Eye, orbitBALL WITH (NONMAGNETIC) FOREIGN BODY	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
930	FOREIGN BODY ON EXTERNAL Eye, orbit	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
930.0	CORNEAL FOREIGN BODY	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
930.1	FOREIGN BODY IN CONJUNCTIVAL SAC	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
930.8	FOREIGN BODY IN OTHER AND COMBINED SITES ON EXTERNAL Eye, orbit	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
930.9	FOREIGN BODY IN UNSPECIFIED SITE ON EXTERNAL Eye, orbit	Eye, orbit	0119	Eye, orbit - Foreign body	011	Superficial injury
372.05	ACUTE ATOPIC CONJUNCTIVITIS	Eye, orbit	0133	Eye, orbit - Allergy	012	Allergy, irritation
372.14	OTHER CHRONIC ALLERGIC CONJUNCTIVITIS	Eye, orbit	0133	Eye, orbit - Allergy	012	Allergy, irritation
372.72	CONJUNCTIVAL HEMORRHAGE	Eye, orbit	0147	Eye, orbit - Hemmorhage	018	Hemmorhage
370.2	SUPERFICIAL KERATITIS WITHOUT CONJUNCTIVITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
370.20	SUPERFICIAL KERATITIS, UNSPECIFIED	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
370.21	PUNCTATE KERATITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
370.24	PHOTOKERATITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
370.40	KERATOCONJUNCTIVITIS, UNSPECIFIED	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury
370.9	UNSPECIFIED KERATITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
372.0	ACUTE CONJUNCTIVITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
372.00	ACUTE CONJUNCTIVITIS, UNSPECIFIED	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury
372.03	OTHER MUCOPURULENT CONJUNCTIVITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	012	Allergy, irritation
372.04	PSEUDOMEMBRANOUS CONJUNCTIVITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury
372.20	BLEPHAROCONJUNCTIVITIS, UNSPECIFIED	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury
372.3	OTHER AND UNSPECIFIED CONJUNCTIVITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury
372.30	CONJUNCTIVITIS, UNSPECIFIED	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury
372.39	OTHER CONJUNCTIVITIS	Eye, orbit	0197	Eye, orbit - Unspecified injury	019	Symptoms, unspecified injury

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
910	SUPERFICIAL INJURY OF FACE, NECK, AND SCALP EXCEPT Eye, orbit	Head	0207	Head - Abrasion, contusion	082	Superficial trauma
910.0	ABRASION OR FRICTION BURN OF FACE, NECK, AND SCALP EXCEPT Eye, orbit, WITHOUT MENTION OF INFECTION	Head	0207	Head - Abrasion, contusion	082	Superficial trauma
920	CONTUSION OF Head, AND NECK EXCEPT Eye, orbit(S)	Head	0207	Head - Abrasion, contusion	082	Superficial trauma
873	OTHER OPEN WOUND OF HEAD	Head	0208	Head - Laceration	023	Superficial trauma
873.0	OPEN WOUND OF SCALP, WITHOUT MENTION OF COMPLICATION	Head	0208	Head - Laceration	023	Superficial trauma
873.20	OPEN WOUND OF NOSE, UNSPECIFIED SITE, UNCOMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.4	OPEN WOUND OF FACE, WITHOUT MENTION OF COMPLICATION	Head	0208	Head - Laceration	023	Superficial trauma
873.40	OPEN WOUND OF FACE, UNSPECIFIED SITE, UNCOMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.41	OPEN WOUND OF CHEEK, UNCOMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.42	OPEN WOUND OF FOREHEAD, UNCOMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.43	OPEN WOUND OF LIP, UNCOMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.44	OPEN WOUND OF JAW, UNCOMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.52	OPEN WOUND OF FOREHEAD, COMPLICATED	Head	0208	Head - Laceration	023	Superficial trauma
873.8	OTHER AND UNSPECIFIED OPEN WOUND OF HEAD WITHOUT MENTION OF COMPLICATION	Head	0208	Head - Laceration	023	Superficial trauma
802.0	CLOSED FRACTURE OF NASAL BONES	Head	0210	Head - Fracture	024	Skeletal trauma
941	BURN OF FACE, HEAD, AND NECK	Head	0211	Head - Burn	027	Burn
941.1	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF FACE, HEAD, AND NECK	Head	0211	Head - Burn	027	Burn
941.2	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF FACE, HEAD, AND NECK	Head	0211	Head - Burn	027	Burn
941.3	FULL-THICKNESS SKIN LOSS DUE TO BURN (THIRD DEGREE NOS) OF FACE, HEAD, AND NECK	Head	0211	Head - Burn	027	Burn
941.4	DEEP NECROSIS OF UNDERLYING TISSUES DUE TO BURN (DEEP THIRD DEGREE) OF FACE, HEAD, AND NECK WITHOUT MENTION OF LOSS OF A BODY PART	Head	0211	Head - Burn	027	Burn
941.5	DEEP NECROSIS OF UNDERLYING TISSUES DUE TO BURN (DEEP THIRD DEGREE) OF FACE, HEAD, AND NECK WITH LOSS OF A BODY PART	Head	0211	Head - Burn	027	Burn
307.81	TENSION HEADACHE	Head	0235	Head - Headache	022	Neurologic problems
784.0	HEADACHE	Head	0235	Head - Headache	022	Neurologic problems
959.0	OTHER AND UNSPECIFIED INJURY TO HEAD, FACE AND NECK	Head	0297	Head - Unspecified injury	029	Symptoms, unspecified injury
723.1	CERVICALGIA	Neck	0301	Neck - Regional pain	031	Soft tissue complaints
723.2	CERVICOCRANIAL SYNDROME	Neck	0301	Neck - Regional pain	031	Soft tissue complaints
723.3	CERVICOBRACHIAL SYNDROME (DIFFUSE)	Neck	0301	Neck - Regional pain	031	Soft tissue complaints
723.5	TORTICOLLIS, UNSPECIFIED	Neck	0301	Neck - Regional pain	031	Soft tissue complaints
723.8	OTHER SYNDROMES AFFECTING CERVICAL REGION	Neck	0301	Neck - Regional pain	031	Soft tissue complaints
723.9	UNSPECIFIED MUSCULOSKELETAL DISORDERS AND Symptoms only REFERABLE TO NECK	Neck	0301	Neck - Regional pain	031	Soft tissue complaints

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
739.1	NONALLOPATHIC LESIONS OF CERVICAL REGION, NOT ELSEWHERE CLASSIFIED	Neck	0301	Neck - Regional pain	031	Soft tissue complaints
847.0	NECK SPRAIN	Neck	0302	Neck - Strain, sprain	031	Soft tissue complaints
722.0	DISPLACEMENT OF CERVICAL INTERVERTEBRAL DISC WITHOUT MYELOPATHY	Neck	0305	Neck - Nerve compression	032	Disc displacement
723.4	BRACHIAL NEURITIS OR RADICULITIS NOS	Neck	0306	Neck - Nerve irritation	031	Soft tissue complaints
874.8	OPEN WOUND OF OTHER AND UNSPECIFIED PARTS OF NECK, WITHOUT MENTION OF COMPLICATION	Neck	0308	Neck - Laceration	033	Superficial trauma
839.0	CLOSED DISLOCATION, CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.01	CLOSED DISLOCATION, FIRST CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.02	CLOSED DISLOCATION, SECOND CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.04	CLOSED DISLOCATION, FOURTH CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.05	CLOSED DISLOCATION, FIFTH CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.06	CLOSED DISLOCATION, SIXTH CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.07	CLOSED DISLOCATION, SEVENTH CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.08	CLOSED DISLOCATION, MULTIPLE CERVICAL VERTEBRAE	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.1	OPEN DISLOCATION, CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.10	OPEN DISLOCATION, CERVICAL VERTEBRA, UNSPECIFIED	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.11	OPEN DISLOCATION, FIRST CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.12	OPEN DISLOCATION, SECOND CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.13	OPEN DISLOCATION, THIRD CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
839.17	OPEN DISLOCATION, SEVENTH CERVICAL VERTEBRA	Neck	0309	Neck - Dislocation	034	Skeletal trauma
805.0	CLOSED FRACTURE OF CERVICAL VERTEBRA WITHOUT MENTION OF SPINAL CORD INJURY	Neck	0310	Neck - Fracture	034	Skeletal trauma
805.1	OPEN FRACTURE OF CERVICAL VERTEBRA WITHOUT MENTION OF SPINAL CORD INJURY	Neck	0310	Neck - Fracture	034	Skeletal trauma
806.0	CLOSED FRACTURE OF CERVICAL VERTEBRA WITH SPINAL CORDINJURY	Neck	0310	Neck - Fracture	034	Skeletal trauma
806.1	OPEN FRACTURE OF CERVICAL VERTEBRA WITH SPINAL CORD INJURY	Neck	0310	Neck - Fracture	034	Skeletal trauma
723.0	SPINAL STENOSIS IN CERVICAL REGION	Neck	0312	Neck - Spinal stenosis	032	Nerve compression
721.1	CERVICAL SPONDYLOSIS WITH MYELOPATHY	Neck	0314	Neck - Cord compression	035	Myelopathy
722.71	INTERVERTEBRAL DISC DISORDER WITH MYELOPATHY, CERVICAL REGION	Neck	0314	Neck - Cord compression	035	Myelopathy
722.81	POSTLAMINECTOMY SYNDROME OF CERVICAL REGION	Neck	0315	Neck - Post surgical neuropathy	032	Nerve compression
721.0	CERVICAL SPONDYLOSIS WITHOUT MYELOPATHY	Neck	0326	Neck - Degenerative disc disease	038	Degenerative disease
722.4	DEGENERATION OF CERVICAL INTERVERTEBRAL DISC	Neck	0326	Neck - Degenerative disc disease	038	Degenerative disease
722.91	OTHER AND UNSPECIFIED DISC DISORDER OF CERVICAL REGION	Neck	0326	Neck - Degenerative disc disease	038	Degenerative disease
724.1	PAIN IN THORACIC SPINE	Thoracic spine	0401	Thoracic spine - Regional pain	041	Soft tissue complaints

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
739.2	NONALLOPATHIC LESIONS OF THORACIC REGION, NOT ELSEWHERE CLASSIFIED	Thoracic spine	0401	Thoracic spine - Regional pain	041	Soft tissue complaints
847.1	THORACIC SPRAIN	Thoracic spine	0402	Thoracic spine - Strain, sprain	041	Soft tissue complaints
839.21	CLOSED DISLOCATION, THORACIC VERTEBRA	Thoracic spine	0409	Thoracic spine - Dislocation	043	Skeletal trauma
805.2	CLOSED FRACTURE OF DORSAL (THORACIC) VERTEBRA WITHOUT MENTION OF SPINAL CORD INJURY	Thoracic spine	0410	Thoracic spine - Fracture	043	Skeletal trauma
724.8	OTHER Symptoms only REFERABLE TO BACK	Low back	0500	Low back - Symptoms only	051	Soft tissue complaints
307.89	OTHER PSYCHALGIA	Low Back	0501	Low Back - Regional pain	051	Soft tissue complaints
724.2	LUMBAGO	Low back	0501	Low back - Regional pain	051	Soft tissue complaints
724.5	BACKACHE, UNSPECIFIED	Low back	0501	Low back - Regional pain	051	Soft tissue complaints
739.3	NONALLOPATHIC LESIONS OF LUMBAR REGION, NOT ELSEWHERE CLASSIFIED	Low back	0501	Low back - Regional pain	051	Soft tissue complaints
739.4	NONALLOPATHIC LESIONS OF SACRAL REGION, NOT ELSEWHERE CLASSIFIED	Low back	0501	Low back - Regional pain	051	Soft tissue complaints
846	SPRAINS AND STRAINS OF SACROILIAC REGION	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
846.0	LUMBOSACRAL (JOINT) (LIGAMENT) SPRAIN	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
846.1	SACROILIAC (LIGAMENT) SPRAIN	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
846.8	OTHER SPECIFIED SITES OF SACROILIAC REGION SPRAIN	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
846.9	UNSPECIFIED SITE OF SACROILIAC REGION SPRAIN	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
847.2	LUMBAR SPRAIN	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
847.3	SPRAIN OF SACRUM	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
847.4	SPRAIN OF COCCYX	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
847.9	SPRAIN OF UNSPECIFIED SITE OF BACK	Low back	0502	Low back - Strain, sprain	051	Soft tissue complaints
720.2	SACROILIITIS, NOT ELSEWHERE CLASSIFIED	Low back	0503	Low back - Enthesopathy	051	Soft tissue complaints
722.1	DISPLACEMENT OF THORACIC OR LUMBAR INTERVERTEBRAL DISC WITHOUT MYELOPATHY	Low back	0505	Low back - disk protrusion with root compression	054	Nerve compression
722.10	DISPLACEMENT OF LUMBAR INTERVERTEBRAL DISC WITHOUT MYELOPATHY	Low back	0505	Low back - disk protrusion with root compression	054	Nerve compression
722.11	DISPLACEMENT OF THORACIC INTERVERTEBRAL DISC WITHOUT MYELOPATHY	Low back	0505	Low back - disk protrusion with root compression	054	Nerve compression
724.3	SCIATICA	Low back	0506	Low back - Nerve irritation	051	Soft tissue complaints
724.4	THORACIC OR LUMBOSACRAL NEURITIS OR RADICULITIS, UNSPECIFIED	Low back	0506	Low back - Nerve irritation	051	Soft tissue complaints
922.3	CONTUSION OF BACK	Low back	0507	Low back - Abrasion, contusion	052	Superficial trauma
922.31	CONTUSION OF BACK	Low back	0507	Low back - Abrasion, contusion	052	Superficial trauma
922.32	CONTUSION OF BUTTOCK	Low back	0507	Low back - Abrasion, contusion	052	Superficial trauma
922.33	CONTUSION OF INTERSCAPULAR REGION	Low Back	0507	Low Back - Abrasion, contusion	052	Superficial trauma
876	OPEN WOUND OF BACK	Low Back	0508	Low Back – Laceration	052	Superficial trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
876.1	OPEN WOUND OF BACK, COMPLICATED	Low Back	0508	Low Back - Laceration	052	Superficial trauma
839.2	CLOSED DISLOCATION, THORACIC AND LUMBAR VERTEBRA	Low back	0509	Low back - Dislocation	053	Skeletal trauma
839.20	CLOSED DISLOCATION, LUMBAR VERTEBRA	Low back	0509	Low back - Dislocation	053	Skeletal trauma
839.3	OPEN DISLOCATION, THORACIC AND LUMBAR VERTEBRA	Low Back	0509	Low Back - Dislocation	053	Skeletal trauma
839.41	CLOSED DISLOCATION, COCCYX	Low Back	0509	Low Back - Dislocation	053	Skeletal trauma
839.42	CLOSED DISLOCATION, SACRUM	Low Back	0509	Low Back - Dislocation	053	Skeletal trauma
839.52	OPEN DISLOCATION, SACRUM	Low Back	0509	Low Back - Dislocation	053	Skeletal trauma
805.4	CLOSED FRACTURE OF LUMBAR VERTEBRA WITHOUT MENTION OF SPINAL CORD INJURY	Low back	0510	Low back - Fracture	053	Skeletal trauma
805.5	OPEN FRACTURE OF LUMBAR VERTEBRA WITHOUT MENTION OF SPINAL CORD INJURY	Low Back	0510	Low Back - Fracture	053	Skeletal trauma
805.6	CLOSED FRACTURE OF SACRUM AND COCCYX WITHOUT MENTION OF SPINAL CORD INJURY	Low back	0510	Low back - Fracture	053	Skeletal trauma
805.7	OPEN FRACTURE OF SACRUM AND COCCYX WITHOUT MENTION OF SPINAL CORD INJURY	Low Back	0510	Low Back - Fracture	053	Skeletal trauma
724.0	SPINAL STENOSIS, OTHER THAN CERVICAL	Low back	0512	Low back - Spinal stenosis	054	Nerve compression
724.00	SPINAL STENOSIS OF UNSPECIFIED REGION	Low Back	0512	Low Back - Spinal stenosis	054	Nerve compression
724.02	SPINAL STENOSIS OF LUMBAR REGION	Low back	0512	Low back - Spinal stenosis	054	Nerve compression
336.8	OTHER MYELOPATHY	Low Back	0514	Low Back - Cord compression	055	Myelopathy
344.6	CAUDA EQUINA SYNDROME	Low Back	0514	Low Back - Cord compression	055	Myelopathy
721.42	SPONDYLOSIS WITH MYELOPATHY, LUMBAR REGION	Low Back	0514	Low Back - Cord compression	055	Myelopathy
722.73	INTERVERTEBRAL DISC DISORDER WITH MYELOPATHY, LUMBAR REGION	Low back	0514	Low back - Cord compression	055	Myelopathy
952.2	LUMBAR SPINAL CORD INJURY WITHOUT SPINAL BONE INJURY	Low back	0514	Low back - Cord compression	055	Myelopathy
722.83	POSTLAMINECTOMY SYNDROME OF LUMBAR REGION	Low back	0515	Low back - Post surgical neuropathy	054	Nerve compression
721.3	LUMBOSACRAL SPONDYLOSIS WITHOUT MYELOPATHY	Low back	0525	Low back - Degenerative arthritis	058	Degenerative disease
722.52	DEGENERATION OF LUMBAR OR LUMBOSACRAL INTERVERTEBRAL DISC	Low back	0526	Low back - Degenerative disc disease	058	Degenerative disease
722.93	OTHER AND UNSPECIFIED DISC DISORDER OF LUMBAR REGION	Low back	0526	Low back - Degenerative disc disease	058	Degenerative disease
724.6	DISORDERS OF SACRUM	Low back	0526	Low back - Degenerative disc disease	058	Degenerative disease
724	OTHER AND UNSPECIFIED DISORDERS OF BACK	Low back	0597	Low back - Unspecified injury	059	Symptoms, unspecified injury
724.79	OTHER DISORDERS OF COCCYX	Low back	0597	Low back - Unspecified injury	059	Symptoms, unspecified injury
724.9	OTHER UNSPECIFIED BACK DISORDERS	Low back	0597	Low back - Unspecified injury	059	Symptoms, unspecified injury
719.41	PAIN IN JOINT INVOLVING SHOULDER REGION	Shoulder	0601	Shoulder - Regional pain	061	Soft tissue complaints
719.42	PAIN IN JOINT INVOLVING UPPER ARM	Shoulder	0601	Shoulder - Regional pain	061	Soft tissue complaints
719.51	STIFFNESS OF JOINT, NOT ELSEWHERE CLASSIFIED, INVOLVING SHOULDER REGION	Shoulder	0601	Shoulder - Regional pain	061	Soft tissue complaints
840	SPRAINS AND STRAINS OF SHOULDER AND UPPER ARM	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
840.0	ACROMIOCLAVICULAR (JOINT) (LIGAMENT) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.1	CORACOCLAVICULAR (LIGAMENT) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.2	CORACOHUMERAL (LIGAMENT) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.3	INFRASPINATUS (MUSCLE) (TENDON) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.4	ROTATOR CUFF (CAPSULE) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.5	SUBSCAPULARIS (MUSCLE) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.6	SUPRASPINATUS (MUSCLE) (TENDON) SPRAIN	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.8	SPRAIN OF OTHER SPECIFIED SITES OF SHOULDER AND UPPER ARM	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
840.9	SPRAIN OF UNSPECIFIED SITE OF SHOULDER AND UPPER ARM	Shoulder	0602	Shoulder - Strain, sprain	061	Soft tissue complaints
726.0	ADHESIVE CAPSULITIS OF SHOULDER	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
726.1	ROTATOR CUFF SYNDROME OF SHOULDER AND ALLIED DISORDERS	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
726.10	DISORDERS OF BURSAE AND TENDONS IN SHOULDER REGION, UNSPECIFIED	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
726.11	CALCIFYING TENDINITIS OF SHOULDER	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
726.12	BICIPITAL TENOSYNOVITIS	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
726.19	OTHER SPECIFIED DISORDERS OF BURSAE AND TENDONS IN SHOULDER REGION	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
726.2	OTHER AFFECTIONS OF SHOULDER REGION, NOT ELSEWHERE CLASSIFIED	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
727.61	COMPLETE RUPTURE OF ROTATOR CUFF	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
727.62	NONTRAUMATIC RUPTURE OF TENDONS OF BICEPS (LONG HEAD)	Shoulder	0603	Shoulder - Enthesopathy	061	Soft tissue complaints
727.6	RUPTURE OF TENDON, NONTRAUMATIC	Shoulder	0604	Shoulder - Tendon, ligament rupture	064	Ligament, tendon rupture
912	SUPERFICIAL INJURY OF SHOULDER AND UPPER ARM	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
912.0	ABRASION OR FRICTION BURN OF SHOULDER AND UPPER ARM, WITHOUT MENTION OF INFECTION	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
923.0	CONTUSION OF SHOULDER AND UPPER ARM	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
923.00	CONTUSION OF SHOULDER REGION	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
923.01	CONTUSION OF SCAPULAR REGION	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
923.03	CONTUSION OF UPPER ARM	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
923.09	CONTUSION OF MULTIPLE SITES OF SHOULDER AND UPPER ARM	Shoulder	0607	Shoulder - Abrasion, contusion	062	Superficial trauma
880.00	OPEN WOUND OF SHOULDER REGION, WITHOUT MENTION OF COMPLICATION	Shoulder	0608	Shoulder - Laceration	062	Superficial trauma
880.10	OPEN WOUND OF SHOULDER REGION, COMPLICATED	Shoulder	0608	Shoulder - Laceration	062	Superficial trauma
880.20	OPEN WOUND OF SHOULDER REGION, WITH TENDON INVOLVEMENT	Shoulder	0608	Shoulder - Laceration	062	Superficial trauma
718.31	RECURRENT DISLOCATION OF JOINT OF SHOULDER REGION	Shoulder	0609	Shoulder - Dislocation	063	Skeletal trauma
831.0	CLOSED DISLOCATION OF SHOULDER	Shoulder	0609	Shoulder - Dislocation	063	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
831.00	CLOSED DISLOCATION OF SHOULDER, UNSPECIFIED SITE	Shoulder	0609	Shoulder - Dislocation	063	Skeletal trauma
831.1	OPEN DISLOCATION OF SHOULDER	Shoulder	0609	Shoulder - Dislocation	063	Skeletal trauma
810.0	CLOSED FRACTURE OF CLAVICLE	Shoulder	0610	Shoulder - Fracture	063	Skeletal trauma
811.0	CLOSED FRACTURE OF SCAPULA	Shoulder	0610	Shoulder - Fracture	063	Skeletal trauma
811.1	OPEN FRACTURE OF SCAPULA	Shoulder	0610	Shoulder - Fracture	063	Skeletal trauma
812.00	FRACTURE OF UNSPECIFIED PART OF UPPER END OF HUMERUS, CLOSED	Shoulder	0610	Shoulder - Fracture	063	Skeletal trauma
812.1	FRACTURE OF UPPER END OF HUMERUS, OPEN	Shoulder	0610	Shoulder - Fracture	063	Skeletal trauma
955.9	INJURY TO UNSPECIFIED NERVE OF SHOULDER GIRDLE AND UPPER LIMB	Shoulder	0697	Shoulder - Unspecified injury	069	Symptoms, unspecified injury
959.2	OTHER AND UNSPECIFIED INJURY TO SHOULDER AND UPPER ARM	Shoulder	0697	Shoulder - Unspecified injury	069	Symptoms, unspecified injury
726.39	OTHER ENTHESOPATHY OF ELBOW REGION	Elbow	0701	Elbow - Regional pain	071	Soft tissue complaints
841	SPRAINS AND STRAINS OF ELBOW AND FOREARM	Elbow	0702	Elbow - Strain, sprain	071	Soft tissue complaints
841.8	SPRAIN OF OTHER SPECIFIED SITES OF ELBOW AND FOREARM	Elbow	0702	Elbow - Strain, sprain	071	Soft tissue complaints
726.3	ENTHESOPATHY OF ELBOW REGION	Elbow	0703	Elbow - Enthesopathy	071	Soft tissue complaints
726.30	ENTHESOPATHY OF ELBOW, UNSPECIFIED	Elbow	0703	Elbow - Enthesopathy	071	Soft tissue complaints
726.31	MEDIAL EPICONDYLITIS	Elbow	0703	Elbow - Enthesopathy	071	Soft tissue complaints
726.32	LATERAL EPICONDYLITIS	Elbow	0703	Elbow - Enthesopathy	071	Soft tissue complaints
726.33	OLECRANON BURSITIS	Elbow	0703	Elbow - Enthesopathy	071	Soft tissue complaints
354.2	LESION OF ULNAR NERVE	Elbow	0705	Elbow - Nerve compression	074	Neuropathy
354.3	LESION OF RADIAL NERVE	Elbow	0705	Elbow - Nerve compression	074	Neuropathy
955.2	INJURY TO ULNAR NERVE	Elbow	0705	Elbow - Nerve compression	074	Neuropathy
913	SUPERFICIAL INJURY OF ELBOW, FOREARM, AND WRIST	Elbow	0707	Elbow - Abrasion, contusion	072	Superficial trauma
913.0	ABRASION OR FRICTION BURN OF ELBOW, FOREARM, AND WRIST, WITHOUT MENTION OF INFECTION	Elbow	0707	Elbow - Abrasion, contusion	072	Superficial trauma
913.6	SUPERFICIAL FOREIGN BODY (SPLINTER) OF ELBOW, FOREARM, AND WRIST, WITHOUT MAJOR OPEN WOUND AND WITHOUT MENTION OF INFECTION	Elbow	0707	Elbow - Abrasion, contusion	072	Superficial trauma
923.1	CONTUSION OF ELBOW AND FOREARM	Elbow	0707	Elbow - Abrasion, contusion	072	Superficial trauma
923.11	CONTUSION OF ELBOW	Elbow	0707	Elbow - Abrasion, contusion	072	Superficial trauma
881.0	OPEN WOUND OF ELBOW, FOREARM, AND WRIST, WITHOUT MENTION OF COMPLICATION	Elbow	0708	Elbow - Laceration	072	Superficial trauma
881.01	OPEN WOUND OF ELBOW, WITHOUT MENTION OF COMPLICATION	Elbow	0708	Elbow - Laceration	072	Superficial trauma
881.11	OPEN WOUND OF ELBOW, COMPLICATED	Elbow	0708	Elbow - Laceration	072	Superficial trauma
881.21	OPEN WOUND OF ELBOW, WITH TENDON INVOLVEMENT	Elbow	0708	Elbow - Laceration	072	Superficial trauma
831.01	CLOSED ANTERIOR DISLOCATION OF HUMERUS	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.02	CLOSED POSTERIOR DISLOCATION OF HUMERUS	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.03	CLOSED INFERIOR DISLOCATION OF HUMERUS	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
831.04	CLOSED DISLOCATION OF ACROMIOCLAVICULAR (JOINT)	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.09	CLOSED DISLOCATION OF OTHER SITE OF SHOULDER	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.10	OPEN DISLOCATION OF SHOULDER, UNSPECIFIED	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.11	OPEN ANTERIOR DISLOCATION OF HUMERUS	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.14	OPEN DISLOCATION OF ACROMIOCLAVICULAR (JOINT)	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
831.19	OPEN DISLOCATION OF OTHER SITE OF SHOULDER	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
832.0	CLOSED DISLOCATION OF ELBOW	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
832.1	OPEN DISLOCATION OF ELBOW	Elbow	0709	Elbow - Dislocation	073	Skeletal trauma
812.4	FRACTURE OF LOWER END OF HUMERUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.40	FRACTURE OF UNSPECIFIED PART OF LOWER END OF HUMERUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.41	SUPRACONDYLAR FRACTURE OF HUMERUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.42	FRACTURE OF LATERAL CONDYLE OF HUMERUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.43	FRACTURE OF MEDIAL CONDYLE OF HUMERUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.44	FRACTURE OF UNSPECIFIED CONDYLE(S) OF HUMERUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.49	OTHER CLOSED FRACTURES OF LOWER END OF HUMERUS	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.50	FRACTURE OF UNSPECIFIED PART OF LOWER END OF HUMERUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.51	SUPRACONDYLAR FRACTURE OF HUMERUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.52	FRACTURE OF LATERAL CONDYLE OF HUMERUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.53	FRACTURE OF MEDIAL CONDYLE OF HUMERUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.54	FRACTURE OF UNSPECIFIED CONDYLE(S) OF HUMERUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
812.59	OTHER FRACTURE OF LOWER END OF HUMERUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.0	FRACTURE OF UPPER END OF RADIUS AND ULNA, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.01	FRACTURE OF OLECRANON PROCESS OF ULNA, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.02	FRACTURE OF CORONOID PROCESS OF ULNA, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.03	MONTEGGIA'S FRACTURE, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.04	OTHER AND UNSPECIFIED CLOSED FRACTURES OF PROXIMAL END OF ULNA (ALONE)	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.05	FRACTURE OF HEAD OF RADIUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.06	FRACTURE OF NECK OF RADIUS, CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.07	OTHER AND UNSPECIFIED CLOSED FRACTURES OF PROXIMAL END OF RADIUS (ALONE)	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.08	FRACTURE OF RADIUS WITH ULNA, UPPER END (ANY PART), CLOSED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.1	FRACTURE OF UPPER END OF RADIUS AND ULNA, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.10	OPEN FRACTURE OF UPPER END OF FOREARM, UNSPECIFIED	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.11	FRACTURE OF OLECRANON PROCESS OF ULNA, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.12	FRACTURE OF CORONOID PROCESS OF ULNA, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.13	MONTEGGIA'S FRACTURE, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.14	OTHER AND UNSPECIFIED OPEN FRACTURES OF PROXIMAL END OF ULNA (ALONE)	Elbow	0710	Elbow - Fracture	073	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
813.15	FRACTURE OF HEAD OF RADIUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.16	FRACTURE OF NECK OF RADIUS, OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.17	OTHER AND UNSPECIFIED OPEN FRACTURES OF PROXIMAL END OF RADIUS (ALONE)	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
813.18	FRACTURE OF RADIUS WITH ULNA, UPPER END (ANY PART), OPEN	Elbow	0710	Elbow - Fracture	073	Skeletal trauma
718.83	OTHER JOINT DERANGEMENT, NOT ELSEWHERE CLASSIFIED, INVOLVING FOREARM	Hand, wrist (inc. forearm)	0800	Hand, wrist (inc. forearm) - Symptoms only	089	Symptoms, unspecified injury
719.43	PAIN IN JOINT INVOLVING FOREARM	Hand, wrist (inc. forearm)	0801	Hand, wrist (inc. forearm) - Regional pain	081	Soft tissue complaints
719.44	PAIN IN JOINT INVOLVING HAND	Hand, wrist (inc. forearm)	0801	Hand, wrist (inc. forearm) - Regional pain	081	Soft tissue complaints
719.53	STIFFNESS OF JOINT, NOT ELSEWHERE CLASSIFIED, INVOLVING FOREARM	Hand, wrist (inc. forearm)	0801	Hand, wrist (inc. forearm) - Regional pain	081	Soft tissue complaints
719.54	STIFFNESS OF JOINT, NOT ELSEWHERE CLASSIFIED, INVOLVING HAND	Hand, wrist (inc. forearm)	0801	Hand, wrist (inc. forearm) - Regional pain	081	Soft tissue complaints
841.0	RADIAL COLLATERAL LIGAMENT SPRAIN	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
841.1	ULNAR COLLATERAL LIGAMENT SPRAIN	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842	SPRAINS AND STRAINS OF WRIST AND HAND	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.0	WRIST SPRAIN	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.00	SPRAIN OF UNSPECIFIED SITE OF WRIST	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.01	SPRAIN OF CARPAL (JOINT) OF WRIST	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.02	SPRAIN OF RADIOCARPAL (JOINT) (LIGAMENT) OF WRIST	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.09	OTHER WRIST SPRAIN	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.1	HAND SPRAIN	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.10	SPRAIN OF UNSPECIFIED SITE OF HAND	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.11	SPRAIN OF CARPOMETACARPAL (JOINT) OF HAND	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.12	SPRAIN OF METACARPOPHALANGEAL (JOINT) OF HAND	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.13	SPRAIN OF INTERPHALANGEAL (JOINT) OF HAND	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
842.19	OTHER HAND SPRAIN	Hand, wrist (inc. forearm)	0802	Hand, wrist (inc. forearm) - Strain, sprain	081	Soft tissue complaints
726.4	ENTHESOPATHY OF WRIST AND CARPUS	Hand, wrist (inc. forearm)	0803	Hand, wrist (inc. forearm) - Enthesopathy	081	Soft tissue complaints
727.03	TRIGGER FINGER (ACQUIRED)	Hand, wrist (inc. forearm)	0803	Hand, wrist (inc. forearm) - Enthesopathy	081	Soft tissue complaints
727.04	RADIAL STYLOID TENOSYNOVITIS	Hand, wrist (inc. forearm)	0803	Hand, wrist (inc. forearm) – Enthesopathy	081	Soft tissue complaints

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
727.05	OTHER TENOSYNOVITIS OF HAND AND WRIST	Hand, wrist (inc. forearm)	0803	Hand, wrist (inc. forearm) - Enthesopathy	081	Soft tissue complaints
354.0	CARPAL TUNNEL SYNDROME	Hand, wrist (inc. forearm)	0805	Hand, wrist (inc. forearm) - Nerve compression	084	Neuropathy
354.1	OTHER LESION OF MEDIAN NERVE	Hand, wrist (inc. forearm)	0805	Hand, wrist (inc. forearm) - Nerve compression	084	Neuropathy
914.0	ABRASION OR FRICTION BURN OF HAND(S) EXCEPT FINGER(S) ALONE, WITHOUT MENTION OF INFECTION	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
915	SUPERFICIAL INJURY OF FINGER(S)	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
915.0	ABRASION OR FRICTION BURN OF FINGERS, WITHOUT MENTION OF INFECTION	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
915.8	OTHER AND UNSPECIFIED SUPERFICIAL INJURY OF FINGERS WITHOUT MENTION OF INFECTION	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
923.10	CONTUSION OF FOREARM	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
923.2	CONTUSION OF WRIST AND HAND(S), EXCEPT FINGER(S) ALONE	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
923.20	CONTUSION OF HAND(S)	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
923.21	CONTUSION OF WRIST	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
923.3	CONTUSION OF FINGER	Hand, wrist (inc. forearm)	0807	Hand, wrist (inc. forearm) - Abrasion, contusion	082	Superficial trauma
881.00	OPEN WOUND OF FOREARM, WITHOUT MENTION OF COMPLICATION	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
881.02	OPEN WOUND OF WRIST, WITHOUT MENTION OF COMPLICATION	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
881.10	OPEN WOUND OF FOREARM, COMPLICATED	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
881.12	OPEN WOUND OF WRIST, COMPLICATED	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
881.20	OPEN WOUND OF FOREARM, WITH TENDON INVOLVEMENT	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
881.22	OPEN WOUND OF WRIST, WITH TENDON INVOLVEMENT	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
882	OPEN WOUND OF HAND EXCEPT FINGER(S) ALONE	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
882.0	OPEN WOUND OF HAND EXCEPT FINGERS ALONE, WITHOUT MENTION OF COMPLICATION	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
882.1	OPEN WOUND OF HAND EXCEPT FINGERS ALONE, COMPLICATED	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
882.2	OPEN WOUND OF HAND EXCEPT FINGERS ALONE, WITH TENDON INVOLVEMENT	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
883	OPEN WOUND OF FINGER(S)	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
883.0	OPEN WOUND OF FINGERS, WITHOUT MENTION OF COMPLICATION	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
883.1	OPEN WOUND OF FINGERS, COMPLICATED	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
883.2	OPEN WOUND OF FINGERS, WITH TENDON INVOLVEMENT	Hand, wrist (inc. forearm)	0808	Hand, wrist (inc. forearm) - Laceration	082	Superficial trauma
833.0	CLOSED DISLOCATION OF WRIST	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.01	CLOSED DISLOCATION OF RADIOULNAR (JOINT), DISTAL	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.02	CLOSED DISLOCATION OF RADIOCARPAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.03	CLOSED DISLOCATION OF MIDCARPAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.04	CLOSED DISLOCATION OF CARPOMETACARPAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.05	CLOSED DISLOCATION OF METACARPAL (BONE), PROXIMAL END	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.09	CLOSED DISLOCATION OF OTHER PART OF WRIST	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.1	OPEN DISLOCATION OF WRIST	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.12	OPEN DISLOCATION OF RADIOCARPAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
833.14	OPEN DISLOCATION OF CARPOMETACARPAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.0	CLOSED DISLOCATION OF FINGER	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.01	CLOSED DISLOCATION OF METACARPOPHALANGEAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.02	CLOSED DISLOCATION OF INTERPHALANGEAL (JOINT), HAND	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.1	OPEN DISLOCATION OF FINGER	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.10	OPEN DISLOCATION OF FINGER, UNSPECIFIED PART	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.11	OPEN DISLOCATION OF METACARPOPHALANGEAL (JOINT)	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
834.12	OPEN DISLOCATION INTERPHALANGEAL (JOINT), HAND	Hand, wrist (inc. forearm)	0809	Hand, wrist (inc. forearm) - Dislocation	083	Skeletal trauma
813.4	FRACTURE OF LOWER END OF RADIUS AND ULNA, CLOSED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
813.41	COLLES' FRACTURE, CLOSED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
813.42	OTHER CLOSED FRACTURES OF DISTAL END OF RADIUS (ALONE)	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
813.5	FRACTURE OF LOWER END OF RADIUS AND ULNA, OPEN	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) – Fracture	083	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
813.8	FRACTURE OF UNSPECIFIED PART OF RADIUS WITH ULNA, CLOSED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
813.81	FRACTURE OF UNSPECIFIED PART OF RADIUS (ALONE), CLOSED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
814	FRACTURE OF CARPAL BONE(S)	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
814.0	CLOSED FRACTURES OF CARPAL BONES	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
814.00	CLOSED FRACTURE OF CARPAL BONE, UNSPECIFIED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
814.01	CLOSED FRACTURE OF NAVICULAR (SCAPHOID) BONE OF WRIST	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
814.1	OPEN FRACTURES OF CARPAL BONES	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
815	FRACTURE OF METACARPAL BONE(S)	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
815.0	CLOSED FRACTURE OF METACARPAL BONES	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
815.00	CLOSED FRACTURE OF METACARPAL BONE(S), SITE UNSPECIFIED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
815.02	CLOSED FRACTURE OF BASE OF OTHER METACARPAL BONE(S)	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
815.03	CLOSED FRACTURE OF SHAFT OF METACARPAL BONE(S)	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
815.1	OPEN FRACTURE OF METACARPAL BONES	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816	FRACTURE OF ONE OR MORE PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.0	CLOSED FRACTURE OF ONE OR MORE PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.00	CLOSED FRACTURE OF PHALANX OR PHALANGES OF HAND, UNSPECIFIED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.01	CLOSED FRACTURE OF MIDDLE OR PROXIMAL PHALANX OR PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.02	CLOSED FRACTURE OF DISTAL PHALANX OR PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.1	OPEN FRACTURE OF ONE OR MORE PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.10	OPEN FRACTURE OF PHALANX OR PHALANGES OF HAND, UNSPECIFIED	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.11	OPEN FRACTURE OF MIDDLE OR PROXIMAL PHALANX OR PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
816.12	OPEN FRACTURE OF DISTAL PHALANX OR PHALANGES OF HAND	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
817.0	MULTIPLE CLOSED FRACTURES OF HAND BONES	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
817.1	MULTIPLE OPEN FRACTURES OF HAND BONES	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) - Fracture	083	Skeletal trauma
834.00	CLOSED DISLOCATION OF FINGER, UNSPECIFIED PART	Hand, wrist (inc. forearm)	0810	Hand, wrist (inc. forearm) – Fracture	083	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
941.00	BURN OF UNSPECIFIED DEGREE OF UNSPECIFIED SITE OF FACE AND HEAD	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
941.10	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF UNSPECIFIED SITE OF FACE AND HEAD	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
943.00	BURN OF UNSPECIFIED DEGREE OF UNSPECIFIED SITE OF UPPER LIMB	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
943.01	BURN OF UNSPECIFIED DEGREE OF FOREARM	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
943.11	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF FOREARM	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
943.20	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF UNSPECIFIED SITE OF UPPER LIMB	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
943.21	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF FOREARM	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944	BURN OF WRIST(S) AND HAND(S)	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.0	BURN OF WRIST(S) AND HAND(S), UNSPECIFIED DEGREE	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.01	BURN OF UNSPECIFIED DEGREE OF SINGLE DIGIT (FINGER (NAIL) OTHER THAN THUMB	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.07	BURN OF UNSPECIFIED DEGREE OF WRIST	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.1	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF WRIST(S) AND HAND(S)	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.10	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF UNSPECIFIED SITE OF HAND	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.2	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF WRIST(S) AND HAND(S)	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.20	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF UNSPECIFIED SITE OF HAND	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.21	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF SINGLE DIGIT (FINGER (NAIL)) OTHER THAN THUMB	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.23	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF TWO OR MORE DIGITS OF HAND, NOT INCLUDING THUMB	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.26	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF BACK OF HAND	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.27	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF WRIST	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.28	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF MULTIPLE SITES OF WRIST(S) AND HAND(S)	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.3	FULL-THICKNESS SKIN LOSS DUE TO BURN (THIRD DEGREE NOS) OF WRIST(S) AND HAND(S)	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
944.4	DEEP NECROSIS OF UNDERLYING TISSUES DUE TO BURN (DEEP THIRD DEGREE) OF WRIST(S) AND HAND(S), WITHOUT MENTION OF LOSS OF A BODY PART	Hand, wrist (inc. forearm)	0811	Hand, wrist (inc. forearm) - Burn	087	Burn
727.41	GANGLION OF JOINT	Hand, wrist (inc. forearm)	0817	Hand, wrist (inc. forearm) - Ganglion	081	Soft tissue complaints
727.42	GANGLION OF TENDON SHEATH	Hand, wrist (inc. forearm)	0817	Hand, wrist (inc. forearm) - Ganglion	081	Soft tissue complaints
727.43	GANGLION, UNSPECIFIED	Hand, wrist (inc. forearm)	0817	Hand, wrist (inc. forearm) - Ganglion	081	Soft tissue complaints
727.49	OTHER GANGLION AND CYST OF SYNOVIUM, TENDON, AND BURSA	Hand, wrist (inc. forearm)	0817	Hand, wrist (inc. forearm) - Ganglion	081	Soft tissue complaints

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
915.6	SUPERFICIAL FOREIGN BODY (SPLINTER) OF FINGERS, WITHOUT MAJOR OPEN WOUND AND WITHOUT MENTION OF INFECTION	Hand, wrist (inc. forearm)	0819	Hand, wrist (inc. forearm) - Foreign body	082	Superficial trauma
681.0	CELLULITIS AND ABSCESS OF FINGER	Hand, wrist (inc. forearm)	0820	Hand, wrist (inc. forearm) - Infection, bacterial	086	Infection
681.00	UNSPECIFIED CELLULITIS AND ABSCESS OF FINGER	Hand, wrist (inc. forearm)	0820	Hand, wrist (inc. forearm) - Infection, bacterial	086	Infection
681.02	ONYCHIA AND PARONYCHIA OF FINGER	Hand, wrist (inc. forearm)	0820	Hand, wrist (inc. forearm) - Infection, bacterial	086	Infection
682.4	CELLULITIS AND ABSCESS OF HAND, EXCEPT FINGERS AND THUMB	Hand, wrist (inc. forearm)	0820	Hand, wrist (inc. forearm) - Infection, bacterial	086	Infection
927.10	CRUSHING INJURY OF FOREARM	Hand, wrist (inc. forearm)	0828	Hand, wrist (inc. forearm) - Crush injury	085	Crush, amputation
927.2	CRUSHING INJURY OF WRIST AND HAND(S), EXCEPT FINGER(S) ALONE	Hand, wrist (inc. forearm)	0828	Hand, wrist (inc. forearm) - Crush injury	085	Crush, amputation
927.20	CRUSHING INJURY OF HAND(S)	Hand, wrist (inc. forearm)	0828	Hand, wrist (inc. forearm) - Crush injury	085	Crush, amputation
927.3	CRUSHING INJURY OF FINGER(S)	Hand, wrist (inc. forearm)	0828	Hand, wrist (inc. forearm) - Crush injury	085	Crush, amputation
885.0	TRAUMATIC AMPUTATION OF THUMB (COMPLETE)(PARTIAL), WITHOUT MENTION OF COMPLICATION	Hand, wrist (inc. forearm)	0829	Hand, wrist (inc. forearm) - Amputation	085	Crush, amputation
886.0	TRAUMATIC AMPUTATION OF OTHER FINGER(S) (COMPLETE) (PARTIAL), WITHOUT MENTION OF COMPLICATION	Hand, wrist (inc. forearm)	0829	Hand, wrist (inc. forearm) - Amputation	085	Crush, amputation
886.1	TRAUMATIC AMPUTATION OF OTHER FINGER(S) (COMPLETE) (PARTIAL), COMPLICATED	Hand, wrist (inc. forearm)	0829	Hand, wrist (inc. forearm) - Amputation	085	Crush, amputation
959.4	OTHER AND UNSPECIFIED INJURY TO HAND, EXCEPT FINGER	Hand, wrist (inc. forearm)	0897	Hand, wrist (inc. forearm) - Unspecified injury	089	Symptoms, unspecified injury
959.5	OTHER AND UNSPECIFIED INJURY TO FINGER	Hand, wrist (inc. forearm)	0897	Hand, wrist (inc. forearm) - Unspecified injury	089	Symptoms, unspecified injury
719.45	PAIN IN JOINT INVOLVING PELVIC REGION AND THIGH	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
726.5	ENTHESOPATHY OF HIP REGION	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
843	SPRAINS AND STRAINS OF HIP AND THIGH	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
843.0	ILIOFEMORAL (LIGAMENT) SPRAIN	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
843.8	SPRAIN OF OTHER SPECIFIED SITES OF HIP AND THIGH	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
843.9	SPRAIN OF UNSPECIFIED SITE OF HIP AND THIGH	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
848.5	PELVIC SPRAIN	Hip, thigh	0902	Hip, thigh - Strain, sprain	091	Soft tissue complaints
924.0	CONTUSION OF HIP AND THIGH	Hip, thigh	0907	Hip, thigh - Abrasion, contusion	092	Superficial trauma
924.00	CONTUSION OF THIGH	Hip, thigh	0907	Hip, thigh - Abrasion, contusion	092	Superficial trauma
924.01	CONTUSION OF HIP	Hip, thigh	0907	Hip, thigh - Abrasion, contusion	092	Superficial trauma
890	OPEN WOUND OF HIP AND THIGH	Hip, thigh	0908	Hip, thigh – Laceration	092	Superficial trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
890.0	OPEN WOUND OF HIP AND THIGH, WITHOUT MENTION OF COMPLICATION	Hip, thigh	0908	Hip, thigh - Laceration	092	Superficial trauma
719.06	EFFUSION OF LOWER LEG JOINT	Knee	1000	Knee - Symptoms only	101	Soft tissue complaints
719.56	STIFFNESS OF JOINT, NOT ELSEWHERE CLASSIFIED, INVOLVING LOWER LEG	Knee	1000	Knee - Symptoms only	101	Soft tissue complaints
719.66	OTHER Symptoms only REFERABLE TO LOWER LEG JOINT	Knee	1000	Knee - Symptoms only	101	Soft tissue complaints
719.76	DIFFICULTY IN WALKING INVOLVING LOWER LEG JOINT	Knee	1000	Knee - Symptoms only	101	Soft tissue complaints
717.82	OLD DISRUPTION OF MEDIAL COLLATERAL LIGAMENT	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
717.83	OLD DISRUPTION OF ANTERIOR CRUCIATE LIGAMENT	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
717.84	OLD DISRUPTION OF POSTERIOR CRUCIATE LIGAMENT	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
717.9	UNSPECIFIED INTERNAL DERANGEMENT OF KNEE	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
844	SPRAINS AND STRAINS OF KNEE AND LEG	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
844.0	SPRAIN OF LATERAL COLLATERAL LIGAMENT OF KNEE	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
844.1	SPRAIN OF MEDIAL COLLATERAL LIGAMENT OF KNEE	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
844.2	SPRAIN OF CRUCIATE LIGAMENT OF KNEE	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
844.3	SPRAIN OF TIBIOFIBULAR (JOINT) (LIGAMENT) SUPERIOR, OF KNEE	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
844.8	SPRAIN OF OTHER SPECIFIED SITES OF KNEE AND LEG	Knee	1002	Knee - Strain, sprain	101	Soft tissue complaints
726.6	ENTHESOPATHY OF KNEE	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.60	ENTHESOPATHY OF KNEE, UNSPECIFIED	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.61	PES ANSERINUS TENDINITIS OR BURSITIS	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.62	TIBIAL COLLATERAL LIGAMENT BURSITIS	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.63	FIBULAR COLLATERAL LIGAMENT BURSITIS	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.64	PATELLAR TENDINITIS	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.65	PREPATELLAR BURSITIS	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
726.69	OTHER ENTHESOPATHY OF KNEE	Knee	1003	Knee - Enthesopathy	101	Soft tissue complaints
844.9	SPRAIN OF UNSPECIFIED SITE OF KNEE AND LEG	Knee	1004	Knee - Tendon, ligament rupture	105	Internal Derangement
822.1	OPEN FRACTURE OF PATELLA	Knee	1007	Knee - Abrasion, contusion	102	Superficial trauma
924.1	CONTUSION OF KNEE AND LOWER LEG	Knee	1007	Knee - Abrasion, contusion	102	Superficial trauma
924.11	CONTUSION OF KNEE	Knee	1007	Knee - Abrasion, contusion	102	Superficial trauma
891	OPEN WOUND OF KNEE, LEG (EXCEPT THIGH), AND ANKLE	Knee	1008	Knee - Laceration	102	Superficial trauma
894.0	MULTIPLE AND UNSPECIFIED OPEN WOUND OF LOWER LIMB, WITHOUT MENTION OF COMPLICATION	Knee	1008	Knee - Laceration	102	Superficial trauma
836.3	DISLOCATION OF PATELLA, CLOSED	Knee	1009	Knee - Dislocation	103	Skeletal trauma
836.4	DISLOCATION OF PATELLA, OPEN	Knee	1009	Knee - Dislocation	103	Skeletal trauma
836.5	OTHER DISLOCATION OF KNEE, CLOSED	Knee	1009	Knee - Dislocation	103	Skeletal trauma
821.2	FRACTURE OF LOWER END OF FEMUR, CLOSED	Knee	1010	Knee - Fracture	103	Skeletal trauma
821.3	FRACTURE OF LOWER END OF FEMUR, OPEN	Knee	1010	Knee - Fracture	103	Skeletal trauma
822.0	CLOSED FRACTURE OF PATELLA	Knee	1010	Knee - Fracture	103	Skeletal trauma
823.0	FRACTURE OF UPPER END OF TIBIA AND FIBULA, CLOSED	Knee	1010	Knee - Fracture	103	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
823.1	FRACTURE OF UPPER END OF TIBIA AND FIBULA, OPEN	Knee	1010	Knee - Fracture	103	Skeletal trauma
717	INTERNAL DERANGEMENT OF KNEE	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.0	OLD BUCKET HANDLE TEAR OF MEDIAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.1	DERANGEMENT OF ANTERIOR HORN OF MEDIAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.2	DERANGEMENT OF POSTERIOR HORN OF MEDIAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.3	OTHER AND UNSPECIFIED DERANGEMENT OF MEDIAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.4	DERANGEMENT OF LATERAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.41	BUCKET HANDLE TEAR OF LATERAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.42	DERANGEMENT OF ANTERIOR HORN OF LATERAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.43	DERANGEMENT OF POSTERIOR HORN OF LATERAL MENISCUS	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.5	DERANGEMENT OF MENISCUS, NOT ELSEWHERE CLASSIFIED	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
836	DISLOCATION OF KNEE	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
836.0	TEAR OF MEDIAL CARTILAGE OR MENISCUS OF KNEE, CURRENT	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
836.1	TEAR OF LATERAL CARTILAGE OR MENISCUS OF KNEE, CURRENT	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
836.2	OTHER TEAR OF CARTILAGE OR MENISCUS OF KNEE, CURRENT	Knee	1013	Knee - Meniscus tear	105	Internal Derangement
717.7	CHONDROMALACIA OF PATELLA	Knee	1016	Knee - Patellofemoral syndrome	101	Soft tissue complaints
719.96	UNSPECIFIED DISORDER OF LOWER LEG JOINT	Knee	1097	Knee - Unspecified injury	109	Symptoms, unspecified injury
719.47	PAIN IN JOINT INVOLVING ANKLE AND FOOT	Ankle, foot (inc. lower leg)	1101	Ankle, foot (inc. lower leg) - Regional pain	111	Soft tissue complaints
719.57	STIFFNESS OF JOINT, NOT ELSEWHERE CLASSIFIED, INVOLVING ANKLE AND FOOT	Ankle, foot (inc. lower leg)	1101	Ankle, foot (inc. lower leg) - Regional pain	111	Soft tissue complaints
845	SPRAINS AND STRAINS OF ANKLE AND FOOT	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.0	ANKLE SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.00	UNSPECIFIED SITE OF ANKLE SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.01	DELTOID (LIGAMENT), ANKLE SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.02	CALCANEOFIBULAR (LIGAMENT) ANKLE SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.09	OTHER ANKLE SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.1	FOOT SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.10	UNSPECIFIED SITE OF FOOT SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
845.19	OTHER FOOT SPRAIN	Ankle, foot (inc. lower leg)	1102	Ankle, foot (inc. lower leg) - Strain, sprain	111	Soft tissue complaints
726.7	ENTHESOPATHY OF ANKLE AND TARSUS	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.70	ENTHESOPATHY OF ANKLE AND TARSUS, UNSPECIFIED	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
726.71	ACHILLES BURSITIS OR TENDINITIS	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.72	TIBIALIS TENDINITIS	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.73	CALCANEAL SPUR	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.79	OTHER ENTHESOPATHY OF ANKLE AND TARSUS	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.8	OTHER PERIPHERAL ENTHESOPATHIES	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.9	UNSPECIFIED ENTHESOPATHY	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.90	ENTHESOPATHY OF UNSPECIFIED SITE	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
726.91	EXOSTOSIS OF UNSPECIFIED SITE	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
727.06	TENOSYNOVITIS OF FOOT AND ANKLE	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
728.71	PLANTAR FASCIAL FIBROMATOSIS	Ankle, foot (inc. lower leg)	1103	Ankle, foot (inc. lower leg) - Enthesopathy	111	Soft tissue complaints
355.5	TARSAL TUNNEL SYNDROME	Ankle, foot (inc. lower leg)	1105	Ankle, foot (inc. lower leg) - Nerve compression	114	Neuropathy
355.6	LESION OF PLANTAR NERVE	Ankle, foot (inc. lower leg)	1105	Ankle, foot (inc. lower leg) - Nerve compression	114	Neuropathy
917	SUPERFICIAL INJURY OF FOOT AND TOE(S)	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
917.0	ABRASION OR FRICTION BURN OF FOOT AND TOE(S), WITHOUT MENTION OF INFECTION	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
924.10	CONTUSION OF LOWER LEG	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
924.2	CONTUSION OF ANKLE AND FOOT, EXCLUDING TOE(S)	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
924.20	CONTUSION OF FOOT	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
924.21	CONTUSION OF ANKLE	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
924.3	CONTUSION OF TOE	Ankle, foot (inc. lower leg)	1107	Ankle, foot (inc. lower leg) - Abrasion, contusion	112	Superficial trauma
892	OPEN WOUND OF FOOT EXCEPT TOE(S) ALONE	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) - Laceration	112	Superficial trauma
892.0	OPEN WOUND OF FOOT EXCEPT TOE(S) ALONE, WITHOUT MENTION OF COMPLICATION	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) - Laceration	112	Superficial trauma
892.1	OPEN WOUND OF FOOT EXCEPT TOE(S) ALONE, COMPLICATED	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) – Laceration	112	Superficial trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
892.2	OPEN WOUND OF FOOT EXCEPT TOE(S) ALONE, WITH TENDON INVOLVEMENT	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) - Laceration	112	Superficial trauma
893.0	OPEN WOUND OF TOE(S), WITHOUT MENTION OF COMPLICATION	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) - Laceration	112	Superficial trauma
893.1	OPEN WOUND OF TOE(S), COMPLICATED	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) - Laceration	112	Superficial trauma
893.2	OPEN WOUND OF TOE(S), WITH TENDON INVOLVEMENT	Ankle, foot (inc. lower leg)	1108	Ankle, foot (inc. lower leg) - Laceration	112	Superficial trauma
837.0	CLOSED DISLOCATION OF ANKLE	Ankle, foot (inc. lower leg)	1109	Ankle, foot (inc. lower leg) - Dislocation	113	Skeletal trauma
837.1	OPEN DISLOCATION OF ANKLE	Ankle, foot (inc. lower leg)	1109	Ankle, foot (inc. lower leg) - Dislocation	113	Skeletal trauma
838.0	CLOSED DISLOCATION OF FOOT	Ankle, foot (inc. lower leg)	1109	Ankle, foot (inc. lower leg) - Dislocation	113	Skeletal trauma
838.1	OPEN DISLOCATION OF FOOT	Ankle, foot (inc. lower leg)	1109	Ankle, foot (inc. lower leg) - Dislocation	113	Skeletal trauma
824	FRACTURE OF ANKLE	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.0	FRACTURE OF MEDIAL MALLEOLUS, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.1	FRACTURE OF MEDIAL MALLEOLUS, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.2	FRACTURE OF LATERAL MALLEOLUS, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.3	FRACTURE OF LATERAL MALLEOLUS, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.4	BIMALLEOLAR FRACTURE, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.5	BIMALLEOLAR FRACTURE, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.6	TRIMALLEOLAR FRACTURE, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.7	TRIMALLEOLAR FRACTURE, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.8	UNSPECIFIED FRACTURE OF ANKLE, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
824.9	UNSPECIFIED FRACTURE OF ANKLE, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825	FRACTURE OF ONE OR MORE TARSAL AND METATARSAL BONES	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.0	FRACTURE OF CALCANEUS, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.1	FRACTURE OF CALCANEUS, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.2	FRACTURE OF OTHER TARSAL AND METATARSAL BONES, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.20	FRACTURE OF UNSPECIFIED BONE(S) OF FOOT (EXCEPT TOES), CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.21	FRACTURE OF ASTRAGALUS, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
825.22	FRACTURE OF NAVICULAR (SCAPHOID) BONE OF FOOT, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.23	FRACTURE OF CUBOID BONE, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.24	FRACTURE OF CUNEIFORM BONE OF FOOT, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.25	FRACTURE OF METATARSAL BONE(S), CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.29	OTHER FRACTURE OF TARSAL AND METATARSAL BONES, CLOSED	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.3	FRACTURE OF OTHER TARSAL AND METATARSAL BONES, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.30	FRACTURE OF UNSPECIFIED BONE(S) OF FOOT (EXCEPT TOES), OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.31	FRACTURE OF ASTRAGALUS, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.32	FRACTURE OF NAVICULAR (SCAPHOID) BONE OF FOOT, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.33	FRACTURE OF CUBOID BONE, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.34	FRACTURE OF CUNEIFORM BONE OF FOOT, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.35	FRACTURE OF METATARSAL BONE(S), OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
825.39	OTHER FRACTURES OF TARSAL AND METATARSAL BONES, OPEN	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
826	FRACTURE OF ONE OR MORE PHALANGES OF FOOT	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
826.0	CLOSED FRACTURE OF ONE OR MORE PHALANGES OF FOOT	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
826.1	OPEN FRACTURE OF ONE OR MORE PHALANGES OF FOOT	Ankle, foot (inc. lower leg)	1110	Ankle, foot (inc. lower leg) - Fracture	113	Skeletal trauma
682.7	CELLULITIS AND ABSCESS OF FOOT, EXCEPT TOES	Ankle, foot (inc. lower leg)	1120	Ankle, foot (inc. lower leg) - Infection, bacterial	116	Infection
703.0	INGROWING NAIL	Ankle, foot (inc. lower leg)	1120	Ankle, foot (inc. lower leg) - Infection, bacterial	116	Infection
928.20	CRUSHING INJURY OF FOOT	Ankle, foot (inc. lower leg)	1128	Ankle, foot (inc. lower leg) - Crush injury	115	Crush, amputation
928.3	CRUSHING INJURY OF TOE(S)	Ankle, foot (inc. lower leg)	1128	Ankle, foot (inc. lower leg) - Crush injury	115	Crush, amputation
786.09	OTHER	Respiratory	1200	Respiratory - Symptoms only	129	Symptoms, unspecified injury
786.2	COUGH	Respiratory	1200	Respiratory - Symptoms only	129	Symptoms, unspecified injury
506.0	BRONCHITIS AND PNEUMONITIS DUE TO FUMES AND VAPORS	Respiratory	1234	Respiratory - Inhalation injury	122	Toxic exposure
493.90	ASTHMA, UNSPECIFIED TYPE, WITHOUT MENTION OF STATUS ASTHMATICUS	Respiratory	1241	Respiratory - Airway disease	121	Airway disease
519.1	OTHER DISEASES OF TRACHEA AND BRONCHUS, NOT ELSEWHERE CLASSIFIED	Respiratory	1297	Respiratory - Unspecified injury	129	Symptoms, unspecified injury
550	INGUINAL HERNIA	Hernia	1430	Gaatrointestinal - Hernia	141	Hernia

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550.9	INGUINAL HERNIA, WITHOUT MENTION OF OBSTRUCTION OR GANGRENE	Gastrointestinal	1430	Gastrointestinal - Hernia	141	Hernia
550.90	UNILATERAL OR UNSPECIFIED INGUINAL HERNIA, WITHOUT MENTION OF OBSTRUCTION OR GANGRENE	Gastrointestinal	1430	Gastrointestinal - Hernia	141	Hernia
550.91	RECURRENT UNILATERAL OR UNSPECIFIED INGUINAL HERNIA, WITHOUT MENTION OF OBSTRUCTION OR GANGRENE	Gastrointestinal	1430	Gastrointestinal - Hernia	141	Hernia
550.92	BILATERAL INGUINAL HERNIA, WITHOUT MENTION OF OBSTRUCTION OR GANGRENE	Gastrointestinal	1430	Gastrointestinal - Hernia	141	Hernia
553.1	UMBILICAL HERNIA WITHOUT MENTION OF OBSTRUCTION OR GANGRENE	Gastrointestinal	1430	Gastrointestinal - Hernia	141	Hernia
558.9	OTHER AND UNSPECIFIED NONINFECTIOUS GASTROENTERITIS AND COLITIS	Gastrointestinal	1445	Gastrointestinal - Stress	149	Symptoms, unspecified injury
599.7	HEMATURIA	Genitourinary	1500	Genitourinary - Symptoms only	159	Symptoms, unspecified
922.4	CONTUSION OF GENITAL ORGANS	Genitourinary	1507	Genitourinary - Abrasion, contusion	152	Superficial trauma
604.90	ORCHITIS AND EPIDIDYMITIS, UNSPECIFIED	Genitourinary	1520	Genitourinary - Infection, bacterial	156	Infection
675.9	UNSPECIFIED INFECTION OF THE BREAST AND NIPPLE ASSOCIATED WITH CHILDBIRTH	Genitourinary	1520	Genitourinary - Infection, bacterial	156	Infection
608.9	UNSPECIFIED DISORDER OF MALE GENITAL ORGANS	Genitourinary	1597	Genitourinary - Unspecified injury	159	Symptoms, unspecified
705.81	DYSHIDROSIS	Dermatologic	1700	Dermatologic - Symptoms only	179	Symptoms, unspecified injury
708.9	UNSPECIFIED URTICARIA	Dermatologic	1700	Dermatologic - Symptoms only	179	Symptoms, unspecified injury
782.1	RASH AND OTHER NONSPECIFIC SKIN ERUPTION	Dermatologic	1700	Dermatologic - Symptoms only	179	Symptoms, unspecified injury
729.6	RESIDUAL FOREIGN BODY IN SOFT TISSUE	Dermatologic	1719	Dermatologic - Foreign body	171	Superficial trauma
686.9	UNSPECIFIED LOCAL INFECTION OF SKIN AND SUBCUTANEOUS TISSUE	Dermatologic	1720	Dermatologic - Infection, bacterial	176	Infection
692	CONTACT DERMATITIS AND OTHER ECZEMA	Dermatologic	1732	Dermatologic - Dermatitis	172	Allergy, irritation
692.5	CONTACT DERMATITIS AND OTHER ECZEMA DUE TO FOOD IN CONTACT WITH SKIN	Dermatologic	1732	Dermatologic - Dermatitis	172	Allergy, irritation
692.89	CONTACT DERMATITIS AND OTHER ECZEMA DUE TO OTHER SPECIFIED AGENTS	Dermatologic	1732	Dermatologic - Dermatitis	172	Allergy, irritation
692.0	CONTACT DERMATITIS AND OTHER ECZEMA DUE TO DETERGENTS	Dermatologic	1733	Dermatologic - Allergy	172	Allergy, irritation
692.4	CONTACT DERMATITIS AND OTHER ECZEMA DUE TO OTHER CHEMICAL PRODUCTS	Dermatologic	1733	Dermatologic - Allergy	172	Allergy, irritation
692.6	CONTACT DERMATITIS AND OTHER ECZEMA DUE TO PLANTS (EXCEPT FOOD)	Dermatologic	1733	Dermatologic - Allergy	172	Allergy, irritation
692.9	CONTACT DERMATITIS AND OTHER ECZEMA, UNSPECIFIED CAUSE	Dermatologic	1733	Dermatologic - Allergy	172	Allergy, irritation
691.8	OTHER ATOPIC DERMATITIS AND RELATED CONDITIONS	Dermatologic	1797	Dermatologic - Unspecified injury	179	Symptoms, unspecified injury
780.3	CONVULSIONS	Neurologic	1800	Neurologic - Symptoms only	189	Symptoms, unspecified injury
353.1	LUMBOSACRAL PLEXUS LESIONS	Neurologic	1806	Neurologic - Nerve irritation	181	Soft tissue complaints
354	MONONEURITIS OF UPPER LIMB AND MONONEURITIS MULTIPLEX	Neurologic	1806	Neurologic - Nerve irritation	181	Soft tissue complaints
354.9	MONONEURITIS OF UPPER LIMB, UNSPECIFIED	Neurologic	1806	Neurologic - Nerve irritation	181	Soft tissue complaints
310.2	POSTCONCUSSION SYNDROME	Neurologic	1839	Neurologic - Concussion	182	CNS trauma

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850	CONCUSSION	Neurologic	1839	Neurologic - Concussion	182	CNS trauma
850.0	CONCUSSION WITH NO LOSS OF CONSCIOUSNESS	Neurologic	1839	Neurologic - Concussion	182	CNS trauma
850.1	CONCUSSION WITH BRIEF LOSS OF CONSCIOUSNESS	Neurologic	1839	Neurologic - Concussion	182	CNS trauma
850.9	CONCUSSION, UNSPECIFIED	Neurologic	1839	Neurologic - Concussion	182	CNS trauma
854.0	INTRACRANIAL INJURY OF OTHER AND UNSPECIFIED NATURE WITHOUT MENTION OF OPEN INTRACRANIAL WOUND	Neurologic	1897	Neurologic - Unspecified injury	189	Symptoms, unspecified injury
854.00	INTRACRANIAL INJURY OF OTHER AND UNSPECIFIED NATURE, WITHOUT MENTION OF OPEN INTRACRANIAL WOUND, WITH STATE OF CONSCIOUSNESS UNSPECIFIED	Neurologic	1897	Neurologic - Unspecified injury	189	Symptoms, unspecified injury
854.01	INTRACRANIAL INJURY OF OTHER AND UNSPECIFIED NATURE, WITHOUT MENTION OF OPEN INTRACRANIAL WOUND, WITH NO LOSS OF CONSCIOUSNESS	Neurologic	1897	Neurologic - Unspecified injury	189	Symptoms, unspecified injury
854.02	INTRACRANIAL INJURY OF OTHER AND UNSPECIFIED NATURE, WITHOUT MENTION OF OPEN INTRACRANIAL WOUND, WITH BRIEF (LESS THAN ONE HOUR) LOSS OF CONSCIOUSNESS	Neurologic	1897	Neurologic - Unspecified injury	189	Symptoms, unspecified injury
729.2	NEURALGIA, NEURITIS, AND RADICULITIS, UNSPECIFIED	Neurologic	1898	Neurologic - Unspecified site	189	Symptoms, unspecified injury
719.4	PAIN IN JOINT	Musculoskele tal	1900	Musculoskeletal - Symptoms only	191	Soft tissue complaints
719.40	PAIN IN JOINT, SITE UNSPECIFIED	Musculoskele tal	1900	Musculoskeletal - Symptoms only	191	Soft tissue complaints
728.85	SPASM OF MUSCLE	Musculoskele tal	1900	Musculoskeletal - Symptoms only	191	Soft tissue complaints
729.1	MYALGIA AND MYOSITIS, UNSPECIFIED	Musculoskele tal	1900	Musculoskeletal - Symptoms only	191	Soft tissue complaints
729.5	PAIN IN LIMB	Musculoskele tal	1900	Musculoskeletal - Symptoms only	191	Soft tissue complaints
841.9	SPRAIN OF UNSPECIFIED SITE OF ELBOW AND FOREARM	Musculoskele tal	1902	Musculoskeletal - Strain, sprain	191	Soft tissue complaints
848.8	OTHER SPECIFIED SITES OF SPRAINS AND STRAINS	Musculoskele tal	1902	Musculoskeletal - Strain, sprain	191	Soft tissue complaints
727.00	SYNOVITIS AND TENOSYNOVITIS, UNSPECIFIED	Musculoskele tal	1903	Musculoskeletal - Enthesopathy	191	Soft tissue complaints
727.09	OTHER SYNOVITIS AND TENOSYNOVITIS	Musculoskele tal	1903	Musculoskeletal - Enthesopathy	191	Soft tissue complaints
722.2	DISPLACEMENT OF INTERVERTEBRAL DISC, SITE UNSPECIFIED, WITHOUT MYELOPATHY	Musculoskele tal	1905	Musculoskeletal - Nerve compression	194	Neuropathy
916.0	ABRASION OR FRICTION BURN OF HIP, THIGH, LEG, AND ANKLE, WITHOUT MENTION OF INFECTION	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
923	CONTUSION OF UPPER LIMB	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
923.9	CONTUSION OF UNSPECIFIED PART OF UPPER LIMB	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
924	CONTUSION OF LOWER LIMB AND OF OTHER AND UNSPECIFIED SITES	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
924.5	CONTUSION OF UNSPECIFIED PART OF LOWER LIMB	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
924.8	CONTUSION OF MULTIPLE SITES, NOT ELSEWHERE CLASSIFIED	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
924.9	CONTUSION OF UNSPECIFIED SITE	Musculoskele tal	1907	Musculoskeletal - Abrasion, contusion	192	Superficial trauma
881	OPEN WOUND OF ELBOW, FOREARM, AND WRIST	Musculoskele tal	1908	Musculoskeletal – Laceration	192	Superficial trauma

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884	MULTIPLE AND UNSPECIFIED OPEN WOUND OF UPPER LIMB	Musculoskeletal	1908	Musculoskeletal - Laceration	192	Superficial trauma
884.0	MULTIPLE AND UNSPECIFIED OPEN WOUND OF UPPER LIMB, WITHOUT MENTION OF COMPLICATION	Musculoskeletal	1908	Musculoskeletal - Laceration	192	Superficial trauma
891.0	OPEN WOUND OF KNEE, LEG (EXCEPT THIGH), AND ANKLE, WITHOUT MENTION OF COMPLICATION	Musculoskeletal	1908	Musculoskeletal - Laceration	192	Superficial trauma
891.1	OPEN WOUND OF KNEE, LEG (EXCEPT THIGH), AND ANKLE, COMPLICATED	Musculoskeletal	1908	Musculoskeletal - Laceration	192	Superficial trauma
829.0	FRACTURE OF UNSPECIFIED BONE, CLOSED	Musculoskeletal	1910	Musculoskeletal - Fracture	193	Skeletal trauma
949.0	BURN OF UNSPECIFIED SITE, UNSPECIFIED DEGREE	Musculoskeletal	1911	Musculoskeletal - Burn	197	Burn
682.3	CELLULITIS AND ABSCESS OF UPPER ARM AND FOREARM	Musculoskeletal	1920	Musculoskeletal - Infection, bacterial	196	Infection
682.6	CELLULITIS AND ABSCESS OF LEG, EXCEPT FOOT	Musculoskeletal	1920	Musculoskeletal - Infection, bacterial	196	Infection
715.96	OSTEOARTHROSIS, UNSPECIFIED WHETHER GENERALIZED OR LOCALIZED, INVOLVING LOWER LEG	Musculoskeletal	1925	Musculoskeletal - Degenerative arthritis	198	Degenerative disease
722.6	DEGENERATION OF INTERVERTEBRAL DISC, SITE UNSPECIFIED	Musculoskeletal	1926	Musculoskeletal - Degenerative disc disease	198	Degenerative disease
928.9	CRUSHING INJURY OF UNSPECIFIED SITE OF LOWER LIMB	Musculoskeletal	1928	Musculoskeletal - Crush injury	195	Crush, amputation
929.9	CRUSHING INJURY OF UNSPECIFIED SITE	Musculoskeletal	1928	Musculoskeletal - Crush injury	195	Crush, amputation
718.84	OTHER JOINT DERANGEMENT, NOT ELSEWHERE CLASSIFIED, INVOLVING HAND	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
728.9	UNSPECIFIED DISORDER OF MUSCLE, LIGAMENT, AND FASCIA	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
729.89	OTHER MUSCULOSKELETAL Symptoms only REFERABLE TO LIMBS	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
729.9	OTHER AND UNSPECIFIED DISORDERS OF SOFT TISSUE	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
733.99	OTHER DISORDERS OF BONE AND CARTILAGE	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
959.3	OTHER AND UNSPECIFIED INJURY TO ELBOW, FOREARM, AND WRIST	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
959.7	OTHER AND UNSPECIFIED INJURY TO KNEE, LEG, ANKLE, AND FOOT	Musculoskeletal	1997	Musculoskeletal - Unspecified injury	199	Symptoms, unspecified injury
718.86	OTHER JOINT DERANGEMENT, NOT ELSEWHERE CLASSIFIED, INVOLVING LOWER LEG	Musculoskeletal	1998	Musculoskeletal - Unspecified site	199	Symptoms, unspecified injury
718.87	OTHER JOINT DERANGEMENT, NOT ELSEWHERE CLASSIFIED, INVOLVING ANKLE AND FOOT	Musculoskeletal	1998	Musculoskeletal - Unspecified site	199	Symptoms, unspecified injury
727	OTHER DISORDERS OF SYNOVIUM, TENDON, AND BURSA	Musculoskeletal	1998	Musculoskeletal - Unspecified site	199	Symptoms, unspecified injury
727.0	SYNOVITIS AND TENOSYNOVITIS	Musculoskeletal	1998	Musculoskeletal - Unspecified site	199	Symptoms, unspecified injury
847	SPRAINS AND STRAINS OF OTHER AND UNSPECIFIED PARTS OF BACK	Musculoskeletal	1998	Musculoskeletal - Unspecified site	199	Symptoms, unspecified injury
848.3	SPRAIN OF RIBS	Trunk	2302	Trunk - Strain, sprain	231	Soft tissue complaints
911.0	ABRASION OR FRICTION BURN OF TRUNK, WITHOUT MENTION OF INFECTION	Trunk	2307	Trunk - Abrasion, contusion	232	Superficial trauma
922	CONTUSION OF TRUNK	Trunk	2307	Trunk - Abrasion, contusion	232	Superficial trauma

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922.0	CONTUSION OF BREAST	Trunk	2307	Trunk - Abrasion, contusion	232	Superficial trauma
922.1	CONTUSION OF CHEST WALL	Trunk	2307	Trunk - Abrasion, contusion	232	Superficial trauma
922.9	CONTUSION OF UNSPECIFIED PART OF TRUNK	Trunk	2307	Trunk - Abrasion, contusion	232	Superficial trauma
807.0	CLOSED FRACTURE OF RIB(S)	Trunk	2310	Trunk - Fracture	233	Skeletal trauma
807.00	CLOSED FRACTURE OF RIB(S), UNSPECIFIED	Trunk	2310	Trunk - Fracture	233	Skeletal trauma
807.01	CLOSED FRACTURE OF ONE RIB	Trunk	2310	Trunk - Fracture	233	Skeletal trauma
942	BURN OF TRUNK	Trunk	2311	Trunk - Burn	238	Burns
942.1	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF TRUNK	Trunk	2311	Trunk - Burn	238	Burns
942.2	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF TRUNK	Trunk	2311	Trunk - Burn	238	Burns
942.3	FULL-THICKNESS SKIN LOSS DUE TO BURN (THIRD DEGREE NOS) OF TRUNK	Trunk	2311	Trunk - Burn	238	Burns
942.4	DEEP NECROSIS OF UNDERLYING TISSUES DUE TO BURN (DEEP THIRD DEGREE) OF TRUNK WITHOUT MENTION OF LOSS OF BODY PART	Trunk	2311	Trunk - Burn	238	Burns
942.5	DEEP NECROSIS OF UNDERLYING TISSUES DUE TO BURN (DEEP THIRD DEGREE) OF TRUNK WITH LOSS OF A BODY PART	Trunk	2311	Trunk - Burn	238	Burns
959.1	OTHER AND UNSPECIFIED INJURY TO TRUNK	Trunk	2397	Trunk - Unspecified injury	239	Symptoms, unspecified injury
V54.8	OTHER ORTHOPEDIC AFTERCARE	Health system contact	2431	Health system contact - Examination	241	Examinations
V67.0	FOLLOW-UP EXAMINATION FOLLOWING SURGERY	Health system contact	2431	Health system contact - Examination	241	Examinations
V67.4	FOLLOWING TREATMENT OF HEALED FRACTURE	Health system contact	2431	Health system contact - Examination	241	Examinations
V67.59	OTHER FOLLOW-UP EXAMINATION	Health system contact	2431	Health system contact - Examination	241	Examinations
V67.9	UNSPECIFIED FOLLOW-UP EXAMINATION	Health system contact	2431	Health system contact - Examination	241	Examinations
V70.0	ROUTINE GENERAL MEDICAL EXAMINATION AT A HEALTH CARE FACILITY	Health system contact	2431	Health system contact - Examination	241	Examinations
V70.5	HEALTH EXAMINATION OF DEFINED SUBPOPULATIONS	Health system contact	2431	Health system contact - Examination	241	Examinations
V70.9	UNSPECIFIED GENERAL MEDICAL EXAMINATION	Health system contact	2431	Health system contact - Examination	241	Examinations
V71.3	OBSERVATION FOLLOWING ACCIDENT AT WORK	Health system contact	2431	Health system contact - Examination	241	Examinations
V71.4	OBSERVATION FOLLOWING OTHER ACCIDENT	Health system contact	2431	Health system contact - Examination	241	Examinations
V71.8	OBSERVATION FOR OTHER SPECIFIED SUSPECTED CONDITIONS	Health system contact	2431	Health system contact - Examination	241	Examinations
V72.5	RADIOLOGICAL EXAMINATION, NOT ELSEWHERE CLASSIFIED	Health system contact	2431	Health system contact - Examination	241	Examinations
V01.7	CONTACT WITH OR EXPOSURE TO OTHER VIRAL DISEASES	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury

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V01.8	CONTACT WITH OR EXPOSURE TO OTHER COMMUNICABLE DISEASES	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V01.9	CONTACT WITH OR EXPOSURE TO UNSPECIFIED COMMUNICABLE DISEASE	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V06.5	NEED FOR PROPHYLACTIC VACCINATION AND INOCULATION AGAINST TETANUS-DIPHTHERIA [TD]	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V45.89	OTHER POSTSURGICAL STATUS	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V57.1	CARE INVOLVING OTHER PHYSICAL THERAPY	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V57.89	CARE INVOLVING OTHER SPECIFIED REHABILITATION Health system contact	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V58.3	ATTENTION TO SURGICAL DRESSINGS AND SUTURES	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V62.1	ADVERSE EFFECTS OF WORK ENVIRONMENT	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
V68.1	ISSUE OF REPEAT PRESCRIPTIONS	Health system contact	2497	Health system contact - Unspecified injury	249	Symptoms, unspecified injury
E920.3	ACCIDENTS CAUSED BY KNIVES, SWORDS, AND DAGGERS	External cause	2508	External cause - Laceration	252	Superficial injury
E920.8	ACCIDENTS CAUSED BY OTHER SPECIFIED CUTTING AND PIERCING INSTRUMENTS OR OBJECTS	External cause	2508	External cause - Laceration	252	Superficial injury
E920.9	ACCIDENTS CAUSED BY UNSPECIFIED CUTTING AND PIERCING INSTRUMENT OR OBJECT	External cause	2508	External cause - Laceration	252	Superficial injury
E812.0	OTHER MOTOR VEHICLE TRAFFIC ACCIDENT INVOLVING COLLISION WITH MOTOR VEHICLE INJURING DRIVER OF MOTOR VEHICLE OTHER THAN MOTORCYCLE	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E849.3	ACCIDENTS OCCURRING IN INDUSTRIAL PLACES AND PREMISES	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E849.6	ACCIDENTS OCCURRING IN PUBLIC BUILDING	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E880.9	ACCIDENTAL FALL ON OR FROM OTHER STAIRS OR STEPS	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E885	FALL ON SAME LEVEL FROM SLIPPING, TRIPPING, OR STUMBLING	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E888	OTHER AND UNSPECIFIED ACCIDENTAL FALL	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E906.0	DOG BITE	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E906.3	BITE OF OTHER ANIMAL EXCEPT ARTHROPOD	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E906.4	BITE OF NONVENOMOUS ARTHROPOD	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E914	FOREIGN BODY ACCIDENTALLY ENTERING Eye, orbit AND ADNEXA	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
E916	STRUCK ACCIDENTALLY BY FALLING OBJECT	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E917.9	OTHER ACCIDENT CAUSED BY STRIKING AGAINST OR BEING STRUCK ACCIDENTALLY BY OBJECTS OR PERSONS	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E918	CAUGHT ACCIDENTALLY IN OR BETWEEN OBJECTS	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E919.8	ACCIDENTS CAUSED BY OTHER SPECIFIED MACHINERY	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E920	ACCIDENTS CAUSED BY CUTTING AND PIERCING INSTRUMENTS OR OBJECTS	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E924.0	ACCIDENT CAUSED BY HOT LIQUIDS AND VAPORS, INCLUDING STEAM	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E924.1	ACCIDENT CAUSED BY CAUSTIC AND CORROSIVE SUBSTANCES	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
E927	OVEREXERTION AND STRENUOUS MOVEMENTS	External cause	2597	External cause - Unspecified injury	259	Symptoms, unspecified injury
998.2	ACCIDENTAL PUNCTURE OR LACERATION DURING A Health system contact, NOT ELSEWHERE CLASSIFIED	Complications of care	2708	Complications of care - Laceration	272	Superficial trauma
995.2	UNSPECIFIED ADVERSE EFFECT OF DRUG, MEDICINAL AND BIOLOGICAL SUBSTANCE, NOT ELSEWHERE CLASSIFIED	Complications of care	2797	Complications of care - Unspecified injury	279	Unspecified injury
999	Complications of care OF MEDICAL CARE, NOT ELSEWHERE CLASSIFIED	Complications of care	2797	Complications of care - Unspecified injury	279	Symptoms, unspecified injury
999.9	OTHER AND UNSPECIFIED Complications of care OF MEDICAL CARE, NOT ELSEWHERE CLASSIFIED	Complications of care	2797	Complications of care - Unspecified injury	279	Symptoms, unspecified injury
931	FOREIGN BODY IN EAR	Ear	2819	Ear - Foreign body	282	Superficial trauma
E928.9	UNSPECIFIED ACCIDENT	Ear	2837	Ear - Noise exposure	283	Acoustic trauma
873.63	OPEN WOUND OF TOOTH (BROKEN), UNCOMPLICATED	Dental	2910	Dental - Fracture	293	Skeletal trauma
922.2	CONTUSION OF ABDOMINAL WALL	Abdomen	3007	Abdomen - Abrasion, contusion	303	Superficial trauma
300.00	ANXIETY STATE, UNSPECIFIED	Psychiatric	3140	Psychiatric - Anxiety	311	Mood disorders
784.7	EPISTAXIS	Head	3247	Head - Hemmorhage	028	Hemmorhage
719.46	PAIN IN JOINT INVOLVING LOWER LEG	Unspecified site	9800	Unspecified site - Symptoms only	989	Symptoms, unspecified injury
848.9	UNSPECIFIED SITE OF SPRAIN AND STRAIN	Unspecified site	9802	Unspecified site - Strain, sprain	981	Soft tissue complaints
919.0	ABRASION OR FRICTION BURN OF OTHER, MULTIPLE, AND UNSPECIFIED SITES, WITHOUT MENTION OF INFECTION	Unspecified site	9807	Unspecified site - Abrasion, contusion	982	Superficial trauma
879.8	OPEN WOUND(S) (MULTIPLE) OF UNSPECIFIED SITE(S), WITHOUT MENTION OF COMPLICATION	Unspecified site	9808	Unspecified site - Laceration	982	Superficial trauma
894	MULTIPLE AND UNSPECIFIED OPEN WOUND OF LOWER LIMB	Unspecified site	9808	Unspecified site - Laceration	982	Superficial trauma
943	BURN OF UPPER LIMB, EXCEPT WRIST AND HAND	Unspecified site	9811	Unspecified site - Burn	988	Burns
943.1	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF UPPER LIMB, EXCEPT WRIST AND HAND	Unspecified site	9811	Unspecified site - Burn	988	Burns
943.2	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF UPPER LIMB, EXCEPT WRIST AND HAND	Unspecified site	9811	Unspecified site - Burn	988	Burns

ICD-9 Code	Description	Body part (Fixed)	Disease Bucket	Bucket Description	Supergroup Code	Supergroup Description
943.3	FULL-THICKNESS SKIN LOSS DUE TO BURN (THIRD DEGREE NOS) OF UPPER LIMB, EXCEPT WRIST AND HAND	Unspecified site	9811	Unspecified site - Burn	988	Burns
944.00	BURN OF UNSPECIFIED DEGREE OF UNSPECIFIED SITE OF HAND	Unspecified site	9811	Unspecified site - Burn	988	Burns
945	BURN OF LOWER LIMB(S)	Unspecified site	9811	Unspecified site - Burn	988	Burns
945.1	ERYTHEMA DUE TO BURN (FIRST DEGREE) OF LOWER LIMB(S)	Unspecified site	9811	Unspecified site - Burn	988	Burns
945.2	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE) OF LOWER LIMB(S)	Unspecified site	9811	Unspecified site - Burn	988	Burns
945.3	FULL-THICKNESS SKIN LOSS DUE TO BURN (THIRD DEGREE NOS) OF LOWER LIMB(S)	Unspecified site	9811	Unspecified site - Burn	988	Burns
949	BURN, UNSPECIFIED SITE	Unspecified site	9811	Unspecified site - Burn	988	Burns
949.1	ERYTHEMA DUE TO BURN (FIRST DEGREE), UNSPECIFIED SITE	Unspecified site	9811	Unspecified site - Burn	988	Burns
949.2	BLISTERS WITH EPIDERMAL LOSS DUE TO BURN (SECOND DEGREE), UNSPECIFIED SITE	Unspecified site	9811	Unspecified site - Burn	988	Burns
919.6	SUPERFICIAL FOREIGN BODY (SPLINTER) OF OTHER, MULTIPLE, AND UNSPECIFIED SITES, WITHOUT MAJOR OPEN WOUND AND WITHOUT MENTION OF INFECTION	Unspecified site	9819	Unspecified site - Foreign body	982	Superficial trauma
682.9	CELLULITIS AND ABSCESS OF UNSPECIFIED SITES	Unspecified site	9820	Unspecified site - Infection, bacterial	986	Infection
958.3	POSTTRAUMATIC WOUND INFECTION NOT ELSEWHERE CLASSIFIED	Unspecified site	9820	Unspecified site - Infection, bacterial	986	Infection
995.3	ALLERGY, UNSPECIFIED, NOT ELSEWHERE CLASSIFIED	Unspecified site	9833	Unspecified site - Allergy	985	Allergy, irritation
799.9	OTHER UNKNOWN AND UNSPECIFIED CAUSE OF MORBIDITY OR MORTALITY	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
848	OTHER AND ILL-DEFINED SPRAINS AND STRAINS	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
919	SUPERFICIAL INJURY OF OTHER, MULTIPLE, AND UNSPECIFIED SITES	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
919.8	OTHER AND UNSPECIFIED SUPERFICIAL INJURY OF OTHER, MULTIPLE, AND UNSPECIFIED SITES, WITHOUT MENTION OF INFECTION	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
959	INJURY, OTHER AND UNSPECIFIED	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
959.8	OTHER AND UNSPECIFIED INJURY TO OTHER SPECIFIED SITES, INCLUDING MULTIPLE	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
959.9	OTHER AND UNSPECIFIED INJURY TO UNSPECIFIED SITE	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury
994.9	OTHER EFFECTS OF EXTERNAL CAUSES	Unspecified site	9897	Unspecified site - Unspecified injury	989	Symptoms, unspecified injury

Arnetz *et al* . 20%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	
Cost Per Fixed Case	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	30.44%	27.36%	24.28%	21.20%	18.12%	15.04%	11.96%	8.88%	5.80%	2.72%	
Savings Per TWCC Case in Dollars	$ 7,217	$ 6,487	$ 5,757	$ 5,026	$ 4,296	$ 3,566	$ 2,836	$ 2,105	$ 1,375	$ 645	
Net TWCC Cost Per Case	$ 19,436	$ 20,166	$ 20,896	$ 21,626	$ 22,357	$ 23,087	$ 23,817	$ 24,547	$ 25,278	$ 26,008	
Total TWCC Spending after Treatment Planning Intervention	$ 70,100,475	$ 109,101,442	$ 131,894,199	$ 156,003,867	$ 181,430,444	$ 187,356,538	$ 193,282,632	$ 199,208,726	$ 205,134,820	$ 211,060,914	
TWCC Cost Per Case	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	
Cost Per Fixed Case	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	
Total TWCC Spending after Treatment Planning Intervention	$ 362,882,485	$ 317,522,174	$ 294,842,019	$ 272,161,864	$ 249,481,708	$ 249,481,708	$ 249,481,708	$ 249,481,708	$ 249,481,708	$ 249,481,708	
Total TWCC Spending for Intervention and Control Groups	$ 432,982,960	$ 426,623,616	$ 426,736,218	$ 428,165,731	$ 430,912,153	$ 436,838,247	$ 442,764,341	$ 448,690,434	$ 454,616,528	$ 460,542,622	
Total TWCC Spending with IG and CG with 5% Discount	$ 412,364,724	$ 386,960,196	$ 368,630,790	$ 352,253,006	$ 337,630,947	$ 325,975,425	$ 314,664,350	$ 303,691,347	$ 293,049,868	$ 282,733,220	
Total TWCC Spending without the IG at 5% Discount	$ 407,207,720	$ 387,816,876	$ 369,349,406	$ 351,761,339	$ 335,010,799	$ 319,057,904	$ 303,864,670	$ 289,394,924	$ 275,614,213	$ 262,489,727	
AMOUNT SAVED	$ (5,157,004)	$ 856,680	$ 718,616	$ (491,667)	$ (2,620,148)	$ (6,917,522)	$ (10,799,680)	$ (14,296,423)	$ (17,435,654)	$ (20,243,493)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Arnetz *et al* . 30%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	
Cost Per Fixed Case	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	30.44%	27.36%	24.28%	21.20%	18.12%	15.04%	11.96%	8.88%	5.80%	2.72%	
Savings Per TWCC Case in Dollars	$ 7,217	$ 6,487	$ 5,757	$ 5,026	$ 4,296	$ 3,566	$ 2,836	$ 2,105	$ 1,375	$ 645	
Net TWCC Cost Per Case	$ 19,436	$ 20,166	$ 20,896	$ 21,626	$ 22,357	$ 23,087	$ 23,817	$ 24,547	$ 25,278	$ 26,008	
Total TWCC Spending after Treatment Planning Intervention	$ 105,150,712	$ 145,468,589	$ 169,578,256	$ 195,004,834	$ 221,748,321	$ 228,991,325	$ 236,234,328	$ 243,477,332	$ 250,720,336	$ 257,963,339	
TWCC Cost Per Case	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	
Cost Per Fixed Case	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	
Total TWCC Spending after Treatment Planning Intervention	$ 317,522,174	$ 272,161,864	$ 249,481,708	$ 226,801,553	$ 204,121,398	$ 204,121,398	$ 204,121,398	$ 204,121,398	$ 204,121,398	$ 204,121,398	
Total TWCC Spending for Intervention and Control Groups	$ 422,672,887	$ 417,630,452	$ 419,059,965	$ 421,806,387	$ 425,869,719	$ 433,112,722	$ 440,355,726	$ 447,598,730	$ 454,841,733	$ 462,084,737	
Total TWCC Spending with IG and CG with 5% Discount	$ 402,545,606	$ 378,803,132	$ 361,999,754	$ 347,021,158	$ 333,680,068	$ 323,195,382	$ 312,952,593	$ 302,952,439	$ 293,195,037	$ 283,679,944	
Total TWCC Spending without the IG at 5% Discount	$ 407,207,720	$ 387,816,876	$ 369,349,406	$ 351,761,339	$ 335,010,799	$ 319,057,904	$ 303,864,670	$ 289,394,924	$ 275,614,213	$ 262,489,727	
AMOUNT SAVED	$ 4,662,114	$ 9,013,745	$ 7,349,652	$ 4,740,181	$ 1,330,731	$ (4,137,478)	$ (9,087,923)	$ (13,557,515)	$ (17,580,823)	$ (21,190,217)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Arnetz *et al* . 40%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	
Cost Per Fixed Case	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	30.44%	27.36%	24.28%	21.20%	18.12%	15.04%	11.96%	8.88%	5.80%	2.72%	
Savings Per TWCC Case in Dollars	$ 7,217	$ 6,487	$ 5,757	$ 5,026	$ 4,296	$ 3,566	$ 2,836	$ 2,105	$ 1,375	$ 645	
Net TWCC Cost Per Case	$ 19,436	$ 20,166	$ 20,896	$ 21,626	$ 22,357	$ 23,087	$ 23,817	$ 24,547	$ 25,278	$ 26,008	
Total TWCC Spending after Treatment Planning Intervention	$ 140,200,950	$ 181,835,736	$ 207,262,313	$ 234,005,801	$ 262,066,197	$ 270,626,111	$ 279,186,024	$ 287,745,938	$ 296,305,851	$ 304,865,765	$ -
TWCC Cost Per Case	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	$ 23,709	
Cost Per Fixed Case	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	$ 444	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	$ 25,153	
Total TWCC Spending after Treatment Planning Intervention	$ 272,161,864	$ 226,801,553	$ 204,121,398	$ 181,441,242	$ 158,761,087	$ 158,761,087	$ 158,761,087	$ 158,761,087	$ 158,761,087	$ 158,761,087	$ -
Total TWCC Spending for Intervention and Control Groups	$ 412,362,813	$ 408,637,289	$ 411,383,711	$ 415,447,043	$ 420,827,284	$ 429,387,198	$ 437,947,111	$ 446,507,025	$ 455,066,938	$ 463,626,852	
Total TWCC Spending with IG and CG with 5% Discount	$ 392,726,489	$ 370,646,067	$ 355,368,717	$ 341,789,310	$ 329,729,189	$ 320,415,338	$ 311,240,836	$ 302,213,530	$ 293,340,206	$ 284,626,669	
Total TWCC Spending without the IG at 5% Discount	$ 407,207,720	$ 387,816,876	$ 369,349,406	$ 351,761,339	$ 335,010,799	$ 319,057,904	$ 303,864,670	$ 289,394,924	$ 275,614,213	$ 262,489,727	
AMOUNT SAVED	$ 14,481,231	$ 17,170,809	$ 13,980,689	$ 9,972,029	$ 5,281,610	$ (1,357,434)	$ (7,376,165)	$ (12,818,606)	$ (17,725,993)	$ (22,136,942)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Baldwin, *et al.* 20%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	
Cost Per Fixed Case	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	17.26%	17.10%	16.94%	16.78%	16.62%	16.46%	16.30%	16.14%	15.98%	15.82%	
Savings Per TWCC Case in Dollars	$ 170	$ 169	$ 167	$ 165	$ 164	$ 162	$ 161	$ 159	$ 158	$ 156	
Net TWCC Cost Per Case	$ 3,384	$ 3,386	$ 3,387	$ 3,389	$ 3,391	$ 3,392	$ 3,394	$ 3,395	$ 3,397	$ 3,398	
Total TWCC Spending after Treatment Planning Intervention	$ 79,152,503	$ 118,784,102	$ 138,646,024	$ 158,526,394	$ 178,425,213	$ 178,508,234	$ 178,591,254	$ 178,674,274	$ 178,757,294	$ 178,840,314	
TWCC Cost Per Case	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	
Cost Per Fixed Case	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	
Total TWCC Spending after Treatment Planning Intervention	$ 192,199,838	$ 168,174,859	$ 156,162,369	$ 144,149,879	$ 132,137,389	$ 132,137,389	$ 132,137,389	$ 132,137,389	$ 132,137,389	$ 132,137,389	
Total TWCC Spending for Intervention and Control Groups	$ 271,352,342	$ 286,958,961	$ 294,808,392	$ 302,676,273	$ 310,562,602	$ 310,645,623	$ 310,728,643	$ 310,811,663	$ 310,894,683	$ 310,977,703	
Total TWCC Spending with IG and CG with 5% Discount	$ 258,430,802	$ 260,280,236	$ 254,666,574	$ 249,012,519	$ 243,333,925	$ 231,808,546	$ 220,829,045	$ 210,369,568	$ 200,405,485	$ 190,913,334	
Total TWCC Spending without the IG at 5% Discount	$ 109,794,630	$ 104,566,315	$ 99,586,966	$ 94,844,730	$ 90,328,314	$ 86,026,966	$ 81,930,444	$ 78,028,994	$ 74,313,328	$ 70,774,598	
AMOUNT SAVED	$ (148,636,171)	$ (155,713,922)	$ (155,079,607)	$ (154,167,789)	$ (153,005,611)	$ (145,781,581)	$ (138,898,601)	$ (132,340,574)	$ (126,092,157)	$ (120,138,736)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Baldwin, *et al.* 30%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	
Cost Per Fixed Case	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	17.26%	17.10%	16.94%	16.78%	16.62%	16.46%	16.30%	16.14%	15.98%	15.82%	
Savings Per TWCC Case in Dollars	$ 170	$ 169	$ 167	$ 165	$ 164	$ 162	$ 161	$ 159	$ 158	$ 156	
Net TWCC Cost Per Case	$ 3,384	$ 3,386	$ 3,387	$ 3,389	$ 3,391	$ 3,392	$ 3,394	$ 3,395	$ 3,397	$ 3,398	
Total TWCC Spending after Treatment Planning Intervention	$ 118,728,755	$ 158,378,803	$ 178,259,173	$ 198,157,993	$ 218,075,261	$ 218,176,730	$ 218,278,199	$ 218,379,668	$ 218,481,137	$ 218,582,606	
TWCC Cost Per Case	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	
Cost Per Fixed Case	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	
Total TWCC Spending after Treatment Planning Intervention	$ 168,174,859	$ 144,149,879	$ 132,137,389	$ 120,124,899	$ 108,112,409	$ 108,112,409	$ 108,112,409	$ 108,112,409	$ 108,112,409	$ 108,112,409	
Total TWCC Spending for Intervention and Control Groups	$ 286,903,614	$ 302,528,681	$ 310,396,562	$ 318,282,892	$ 326,187,670	$ 326,289,139	$ 326,390,608	$ 326,492,077	$ 326,593,546	$ 326,695,016	
Total TWCC Spending with IG and CG with 5% Discount	$ 273,241,537	$ 274,402,432	$ 268,132,221	$ 261,852,123	$ 255,576,575	$ 243,481,979	$ 231,959,712	$ 220,982,689	$ 210,525,112	$ 200,562,400	
Total TWCC Spending without the IG at 5% Discount	$ 109,794,630	$ 104,566,315	$ 99,586,966	$ 94,844,730	$ 90,328,314	$ 86,026,966	$ 81,930,444	$ 78,028,994	$ 74,313,328	$ 70,774,598	
AMOUNT SAVED	$ (163,446,906)	$ (169,836,117)	$ (168,545,254)	$ (167,007,393)	$ (165,248,260)	$ (157,455,013)	$ (150,029,268)	$ (142,953,695)	$ (136,211,784)	$ (129,787,802)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Baldwin, *et al. 40%*

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	
Cost Per Fixed Case	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	17.26%	17.10%	16.94%	16.78%	16.62%	16.46%	16.30%	16.14%	15.98%	15.82%	
Savings Per TWCC Case in Dollars	$ 170	$ 169	$ 167	$ 165	$ 164	$ 162	$ 161	$ 159	$ 158	$ 156	
Net TWCC Cost Per Case	$ 3,384	$ 3,386	$ 3,387	$ 3,389	$ 3,391	$ 3,392	$ 3,394	$ 3,395	$ 3,397	$ 3,398	
Total TWCC Spending after Treatment Planning Intervention	$ 158,305,007	$ 197,973,503	$ 217,872,323	$ 237,789,591	$ 257,725,308	$ 257,845,226	$ 257,965,144	$ 258,085,062	$ 258,204,980	$ 258,324,898	
TWCC Cost Per Case	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	$ 986	
Cost Per Fixed Case	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	$ 68	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 1,000.00	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	$ 2,054	
Total TWCC Spending after Treatment Planning Intervention	$ 144,149,879	$ 120,124,899	$ 108,112,409	$ 96,099,919	$ 84,087,429	$ 84,087,429	$ 84,087,429	$ 84,087,429	$ 84,087,429	$ 84,087,429	
Total TWCC Spending for Intervention and Control Groups	$ 302,454,886	$ 318,098,402	$ 325,984,732	$ 333,889,510	$ 341,812,738	$ 341,932,656	$ 342,052,574	$ 342,172,492	$ 342,292,410	$ 342,412,328	
Total TWCC Spending with IG and CG with 5% Discount	$ 288,052,272	$ 288,524,628	$ 281,597,868	$ 274,691,726	$ 267,819,224	$ 255,155,412	$ 243,090,378	$ 231,595,811	$ 220,644,739	$ 210,211,466	
Total TWCC Spending without the IG at 5% Discount	$ 109,794,630	$ 104,566,315	$ 99,586,966	$ 94,844,730	$ 90,328,314	$ 86,026,966	$ 81,930,444	$ 78,028,994	$ 74,313,328	$ 70,774,598	
AMOUNT SAVED	$ (178,257,642)	$ (183,958,313)	$ (182,010,901)	$ (179,846,996)	$ (177,490,910)	$ (169,128,446)	$ (161,159,934)	$ (153,566,817)	$ (146,331,412)	$ (139,436,868)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Cheadle *et al* . 20%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	46.03%	41.37%	36.71%	32.05%	27.39%	22.73%	18.07%	13.41%	8.75%	4.09%	
Savings Per TWCC Case in Dollars	$ 8,993	$ 8,083	$ 7,172	$ 6,262	$ 5,351	$ 4,441	$ 3,531	$ 2,620	$ 1,710	$ 799	
Net TWCC Cost Per Case	$ 13,201	$ 14,112	$ 15,022	$ 15,933	$ 16,843	$ 17,754	$ 18,664	$ 19,575	$ 20,485	$ 21,396	
Total TWCC Spending after Treatment Planning Intervention	$ 134,799,009	$ 216,143,739	$ 268,437,126	$ 325,378,922	$ 386,969,126	$ 407,886,965	$ 428,804,804	$ 449,722,643	$ 470,640,482	$ 491,558,321	
TWCC Cost Per Case	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 20,695	$ 20,695	$ 20,695	$ 20,695	$ 20,695	$ 20,695	$ 20,695	$ 20,695	$ 20,695	$ 20,695	
Total TWCC Spending after Treatment Planning Intervention	$ 845,254,072	$ 739,597,313	$ 686,768,934	$ 633,940,554	$ 581,112,175	$ 581,112,175	$ 581,112,175	$ 581,112,175	$ 581,112,175	$ 581,112,175	
Total TWCC Spending for Intervention and Control Groups	$ 980,053,081	$ 955,741,052	$ 955,206,060	$ 959,319,476	$ 968,081,301	$ 988,999,140	$ 1,009,916,979	$ 1,030,834,818	$ 1,051,752,657	$ 1,072,670,496	
Total TWCC Spending with IG and CG with 5% Discount	$ 933,383,887	$ 866,885,308	$ 825,142,909	$ 789,234,507	$ 758,517,030	$ 738,006,385	$ 717,729,142	$ 697,709,580	$ 677,969,140	$ 658,526,634	
Total TWCC Spending without the IG at 5% Discount	$ 950,011,990	$ 904,773,324	$ 861,688,880	$ 820,656,076	$ 781,577,216	$ 744,359,253	$ 708,913,574	$ 675,155,785	$ 643,005,510	$ 612,386,200	
AMOUNT SAVED	$ 16,628,104	$ 37,888,016	$ 36,545,971	$ 31,421,569	$ 23,060,185	$ 6,352,868	$ (8,815,567)	$ (22,553,795)	$ (34,963,631)	$ (46,140,434)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Cheadle *et al* . 30%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Percent Savings on TWCC Cost Per Case	46.03%	41.37%	36.71%	32.05%	27.39%	22.73%	18.07%	13.41%	8.75%	4.09%	
Savings Per TWCC Case in Dollars	$ 8,993	$ 8,083	$ 7,172	$ 6,262	$ 5,351	$ 4,441	$ 3,531	$ 2,620	$ 1,710	$ 799	
Net TWCC Cost Per Case	$ 12,201	$ 13,112	$ 14,022	$ 14,933	$ 15,843	$ 16,754	$ 17,664	$ 18,575	$ 19,485	$ 20,396	
Total TWCC Spending after Treatment Planning Intervention	$ 186,882,013	$ 267,769,653	$ 322,158,698	$ 381,196,152	$ 444,882,015	$ 470,448,263	$ 496,014,511	$ 521,580,758	$ 547,147,006	$ 572,713,254	
TWCC Cost Per Case	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	
Total TWCC Spending after Treatment Planning Intervention	$ 703,858,813	$ 603,307,554	$ 553,031,925	$ 502,756,295	$ 452,480,666	$ 452,480,666	$ 452,480,666	$ 452,480,666	$ 452,480,666	$ 452,480,666	
Total TWCC Spending for Intervention and Control Groups	$ 890,740,826	$ 871,077,207	$ 875,190,623	$ 883,952,447	$ 897,362,681	$ 922,928,929	$ 948,495,176	$ 974,061,424	$ 999,627,672	$ 1,025,193,919	
Total TWCC Spending with IG and CG with 5% Discount	$ 848,324,597	$ 790,092,704	$ 756,022,566	$ 727,229,866	$ 703,107,141	$ 688,703,776	$ 674,077,813	$ 659,283,113	$ 644,368,910	$ 629,380,135	
Total TWCC Spending without the IG at 5% Discount	$ 950,011,990	$ 904,773,324	$ 861,688,880	$ 820,656,076	$ 781,577,216	$ 744,359,253	$ 708,913,574	$ 675,155,785	$ 643,005,510	$ 612,386,200	
AMOUNT SAVED	$ 101,687,394	$ 114,680,620	$ 105,666,314	$ 93,426,210	$ 78,470,074	$ 55,655,477	$ 34,835,761	$ 15,872,672	$ (1,363,400)	$ (16,993,935)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Cheadle *et al* . 40%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Percent Savings on TWCC Cost Per Case	46.03%	41.37%	36.71%	32.05%	27.39%	22.73%	18.07%	13.41%	8.75%	4.09%	
Savings Per TWCC Case in Dollars	$ 8,993	$ 8,083	$ 7,172	$ 6,262	$ 5,351	$ 4,441	$ 3,531	$ 2,620	$ 1,710	$ 799	
Net TWCC Cost Per Case	$ 12,201	$ 13,112	$ 14,022	$ 14,933	$ 15,843	$ 16,754	$ 17,664	$ 18,575	$ 19,485	$ 20,396	
Total TWCC Spending after Treatment Planning Intervention	$ 249,176,018	$ 334,712,066	$ 393,749,520	$ 457,435,383	$ 525,769,655	$ 555,984,311	$ 586,198,967	$ 616,413,624	$ 646,628,280	$ 676,842,936	
TWCC Cost Per Case	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	$ 19,538	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	$ 19,695	
Total TWCC Spending after Treatment Planning Intervention	$ 603,307,554	$ 502,756,295	$ 452,480,666	$ 402,205,036	$ 351,929,407	$ 351,929,407	$ 351,929,407	$ 351,929,407	$ 351,929,407	$ 351,929,407	
Total TWCC Spending for Intervention and Control Groups	$ 852,483,572	$ 837,468,361	$ 846,230,186	$ 859,640,419	$ 877,699,061	$ 907,913,717	$ 938,128,374	$ 968,343,030	$ 998,557,686	$ 1,028,772,343	
Total TWCC Spending with IG and CG with 5% Discount	$ 811,889,116	$ 759,608,490	$ 731,005,451	$ 707,228,300	$ 687,700,181	$ 677,499,195	$ 666,710,320	$ 655,412,679	$ 643,679,188	$ 631,576,976	
Total TWCC Spending without the IG at 5% Discount	$ 950,011,990	$ 904,773,324	$ 861,688,880	$ 820,656,076	$ 781,577,216	$ 744,359,253	$ 708,913,574	$ 675,155,785	$ 643,005,510	$ 612,386,200	
AMOUNT SAVED	$ 138,122,874	$ 145,164,834	$ 130,683,429	$ 113,427,776	$ 93,877,035	$ 66,860,058	$ 42,203,254	$ 19,743,106	$ (673,678)	$ (19,190,777)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Lemstra and Olzsynksi 20%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	
Cost Per Fixed Case	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	58.86%	52.90%	46.94%	40.98%	35.02%	29.06%	23.10%	17.14%	11.18%	5.22%	
Savings Per TWCC Case in Dollars	$ 13,551	$ 12,179	$ 10,807	$ 9,434	$ 8,062	$ 6,690	$ 5,318	$ 3,946	$ 2,574	$ 1,202	
Net TWCC Cost Per Case	$ 12,848	$ 14,220	$ 15,592	$ 16,964	$ 18,337	$ 19,709	$ 21,081	$ 22,453	$ 23,825	$ 25,197	
Total TWCC Spending after Treatment Planning Intervention	$ 23,447,733	$ 38,927,753	$ 49,797,893	$ 61,920,083	$ 75,294,325	$ 80,928,557	$ 86,562,788	$ 92,197,020	$ 97,831,252	$ 103,465,483	
TWCC Cost Per Case	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	
Total TWCC Spending after Treatment Planning Intervention	$ 176,504,464	$ 154,441,406	$ 143,409,877	$ 132,378,348	$ 121,346,819	$ 121,346,819	$ 121,346,819	$ 121,346,819	$ 121,346,819	$ 121,346,819	
Total TWCC Spending for Intervention and Control Groups	$ 199,952,197	$ 193,369,160	$ 193,207,770	$ 194,298,431	$ 196,641,144	$ 202,275,376	$ 207,909,608	$ 213,543,839	$ 219,178,071	$ 224,812,302	
Total TWCC Spending with IG and CG with 5% Discount	$ 190,430,664	$ 175,391,528	$ 166,900,136	$ 159,849,800	$ 154,073,482	$ 150,941,000	$ 147,757,476	$ 144,534,876	$ 141,284,139	$ 138,015,252	
Total TWCC Spending without the IG at 5% Discount	$ 200,072,143	$ 190,544,898	$ 181,471,331	$ 172,829,839	$ 164,599,847	$ 156,761,759	$ 149,296,913	$ 142,187,537	$ 135,416,702	$ 128,968,287	
AMOUNT SAVED	$ 9,641,479	$ 15,153,370	$ 14,571,195	$ 12,980,039	$ 10,526,365	$ 5,820,759	$ 1,539,437	$ (2,347,339)	$ (5,867,437)	$ (9,046,965)	$ -
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

Lemstra and Olzsynksi 30%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	
Cost Per Fixed Case	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	58.86%	52.90%	46.94%	40.98%	35.02%	29.06%	23.10%	17.14%	11.18%	5.22%	
Savings Per TWCC Case in Dollars	$ 13,551	$ 12,179	$ 10,807	$ 9,434	$ 8,062	$ 6,690	$ 5,318	$ 3,946	$ 2,574	$ 1,202	
Net TWCC Cost Per Case	$ 12,848	$ 14,220	$ 15,592	$ 16,964	$ 18,337	$ 19,709	$ 21,081	$ 22,453	$ 23,825	$ 25,197	
Total TWCC Spending after Treatment Planning Intervention	$ 35,171,599	$ 51,903,671	$ 64,025,862	$ 77,400,104	$ 92,026,397	$ 98,912,680	$ 105,798,963	$ 112,685,247	$ 119,571,530	$ 126,457,813	$ -
TWCC Cost Per Case	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	
Total TWCC Spending after Treatment Planning Intervention	$ 154,441,406	$ 132,378,348	$ 121,346,819	$ 110,315,290	$ 99,283,761	$ 99,283,761	$ 99,283,761	$ 99,283,761	$ 99,283,761	$ 99,283,761	$ -
Total TWCC Spending for Intervention and Control Groups	$ 189,613,005	$ 184,282,020	$ 185,372,681	$ 187,715,394	$ 191,310,159	$ 198,196,442	$ 205,082,725	$ 211,969,008	$ 218,855,291	$ 225,741,574	
Total TWCC Spending with IG and CG with 5% Discount	$ 180,583,815	$ 167,149,224	$ 160,131,892	$ 154,433,919	$ 149,896,515	$ 147,897,236	$ 145,748,464	$ 143,468,968	$ 141,076,072	$ 138,585,744	
Total TWCC Spending without the IG at 5% Discount	$ 200,072,143	$ 190,544,898	$ 181,471,331	$ 172,829,839	$ 164,599,847	$ 156,761,759	$ 149,296,913	$ 142,187,537	$ 135,416,702	$ 128,968,287	
AMOUNT SAVED	$ 19,488,328	$ 23,395,674	$ 21,339,440	$ 18,395,920	$ 14,703,332	$ 8,864,523	$ 3,548,450	$ (1,281,431)	$ (5,659,370)	$ (9,617,457)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	$ -

Lemstra and Olzsynksi 40%

Cost Center	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
TWCC Cost Per Case	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	
Cost Per Fixed Case	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	$ 877	
Cost Per Treatment Planning	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,500.00	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	58.86%	52.90%	46.94%	40.98%	35.02%	29.06%	23.10%	17.14%	11.18%	5.22%	
Savings Per TWCC Case in Dollars	$ 13,551	$ 12,179	$ 10,807	$ 9,434	$ 8,062	$ 6,690	$ 5,318	$ 3,946	$ 2,574	$ -	
Net TWCC Cost Per Case	$ 12,848	$ 14,220	$ 15,592	$ 16,964	$ 18,337	$ 19,709	$ 21,081	$ 22,453	$ 23,825	$ 25,197	
Total TWCC Spending after Treatment Planning Intervention	$ 46,895,465	$ 64,879,589	$ 78,253,831	$ 92,880,125	$ 108,758,470	$ 116,896,804	$ 125,035,139	$ 133,173,473	$ 141,311,808	$ 149,450,142	$ -
TWCC Cost Per Case	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	$ 23,022	
Cost Per Fixed Case	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	$ 157	
Cost Per Treatment Planning	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Dispute Resolution	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	
Percent Savings on TWCC Cost Per Case	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Savings Per TWCC Case in Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Net TWCC Cost Per Case	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	$ 24,179	
Total TWCC Spending after Treatment Planning Intervention	$ 132,378,348	$ 110,315,290	$ 99,283,761	$ 88,252,232	$ 77,220,703	$ 77,220,703	$ 77,220,703	$ 77,220,703	$ 77,220,703	$ 77,220,703	
Total TWCC Spending for Intervention and Control Groups	$ 179,273,814	$ 175,194,879	$ 177,537,592	$ 181,132,357	$ 185,979,173	$ 194,117,507	$ 202,255,842	$ 210,394,176	$ 218,532,511	$ 226,670,846	
Total TWCC Spending with IG and CG with 5% Discount	$ 170,736,965	$ 158,906,920	$ 153,363,647	$ 149,018,038	$ 145,719,548	$ 144,853,473	$ 143,739,451	$ 142,403,060	$ 140,868,005	$ 139,156,236	
Total TWCC Spending without the IG at 5% Discount	$ 200,072,143	$ 190,544,898	$ 181,471,331	$ 172,829,839	$ 164,599,847	$ 156,761,759	$ 149,296,913	$ 142,187,537	$ 135,416,702	$ 128,968,287	
AMOUNT SAVED	$ 29,335,177	$ 31,637,978	$ 28,107,684	$ 23,811,801	$ 18,880,299	$ 11,908,286	$ 5,557,463	$ (215,524)	$ (5,451,304)	$ (10,187,949)	
	1.05	1.1025	1.157625	1.21550625	1.276281563	1.340095641	1.407100423	1.477455444	1.551328216	1.628894627	

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